

6551

3

FINAL



**U.S. Army  
Environmental  
Center**

## Site Inspection Quality Control Plan

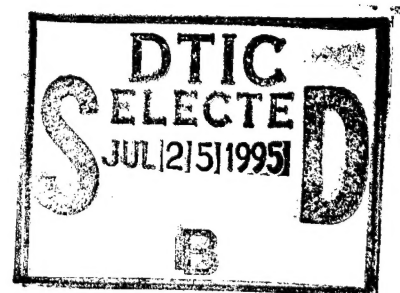
**Bennett Army National Guard Facility  
Bennett, Colorado**

Prepared for:

**U.S. ARMY ENVIRONMENTAL CENTER  
ABERDEEN PROVING GROUND, MARYLAND 21010-5401**

Prepared by:

**CKY, INC. ENVIRONMENTAL SERVICES  
3480 Torrance Boulevard, Suite 100  
Torrance, CA 90503**



Unlimited Distribution  
Approved for Public Release

Requests for this document must be referred to:  
Commander, U.S. Army Environmental Center  
Aberdeen Proving Ground, Maryland 21010

January 1995

DTIC QUALITY INSPECTED 5

19950724 085

# **SITE INSPECTION QUALITY CONTROL PLAN**

**BENNETT ARMY NATIONAL GUARD FACILITY  
BENNETT, COLORADO**

**FINAL**

**USAEC CONTRACT NO. DAAA15-14-D-0013**

**TASK ORDER 0001**

Prepared for:

U.S. Army Environmental Center  
Aberdeen Proving Ground, Maryland 21010-5401

Prepared by:

CKY, Inc. Environmental Services  
3480 Torrance Boulevard, Suite 100  
Torrance, California 90503

THE VIEWS, OPINIONS, AND/OR FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF THE AUTHOR(S) AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL DEPARTMENT OF THE ARMY POSITION, POLICY, OR DECISION, UNLESS SO DESIGNATED BY OTHER DOCUMENTATION.

THE USE OF TRADE NAMES IN THIS REPORT DOES NOT CONSTITUTE AN OFFICIAL ENDORSEMENT OR APPROVAL OF THE USE OF SUCH COMMERCIAL PRODUCTS. THE REPORT MAY NOT BE CITED FOR PURPOSES OF ADVERTISEMENT

CKY Project No. 8802

January 26, 1995

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0 PROJECT DESCRIPTION.....	1
2.0 QUALITY ASSURANCE ROLES AND RESPONSIBILITY.....	2
2.1 RESPONSIBILITIES AND AUTHORITY OF USAEC PERSONNEL.....	2
2.1.1 Geology and Chemistry Branch, Installation Restoration Division.....	2
2.1.2 USAEC Project Officer, Base Closure Division.....	4
2.2 RESPONSIBILITIES AND AUTHORITY OF THE CONTRACTOR PERSONNEL.....	4
2.2.1 Contractor Quality Assurance Coordinator.....	4
2.2.2 Laboratory Analytical Task Manager.....	5
2.2.3 Contractor Program Manager (Project Director).....	6
2.2.4 Contractor Task Manager (Project Manager).....	6
2.2.5 Field Operations Leader.....	7
2.2.6 Data Management Coordinator.....	7
3.0 QUALITY ASSURANCE OBJECTIVES.....	8
3.1 PROJECT OBJECTIVES AND INTENDED DATA USAGES.....	8
3.2 DATA QUALITY OBJECTIVES.....	8
3.2.1 Precision Limits .....	9
3.2.2 Accuracy Limits .....	9
3.2.3 Representativeness.....	10
3.2.4 Comparability.....	11
3.2.5 Completeness.....	11
4.0 FIELD PROCEDURES.....	13
4.1 DRILLING METHODS AND SOIL SAMPLING.....	13
4.1.1 Hand Auger Borings.....	13
4.1.2 Hollow-Stem Auger Borings.....	13
4.1.3 Air Rotary Borings .....	14

r	
<input checked="" type="checkbox"/>	SEARCHED
<input type="checkbox"/>	INDEXED
<input type="checkbox"/>	SERIALIZED
1	
Codes	
Dist	Avail and/or Special
A-1	

## TABLE OF CONTENTS (continued)

<u>Section</u>	<u>Page</u>
4.1.4 Borehole Logging .....	15
4.1.5 Soil Sampling.....	17
4.2 MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING.....	18
4.2.1 Well Construction .....	18
4.2.2 Well Development.....	18
4.2.3 Collection of Groundwater Samples.....	22
4.2.4 Aquifer Testing .....	25
4.3 UNDERGROUND COMPLEX SAMPLING.....	26
4.3.1 Standing Water Sampling.....	27
4.3.2 Tank Sampling .....	27
4.4 DECONTAMINATION PROCEDURES.....	28
4.4.1 Sampling Equipment.....	28
4.4.2 Monitoring Equipment.....	29
4.4.3 Respirators .....	30
4.5 FIELD MEASUREMENTS.....	30
4.5.1 Water-level Measurements .....	30
4.5.2 Conductivity, Temperature, and pH Measurements.....	31
4.5.3 Headspace Analyses.....	31
5.0 SAMPLE COLLECTION AND MANAGEMENT.....	32
5.1 SAMPLING SITES .....	32
5.2 SAMPLE CONTAINERS .....	32
5.2.1 Precleaned Sample Containers.....	34
5.2.1.1 Amber Glass Bottles and Wide-Mouth, Clear Glass Jars.....	34
5.2.1.2 40 ml Borosilicate Glass Vials.....	34
5.2.1.3 Polyethylene Bottles.....	35



# TABLE OF CONTENTS (continued)

<u>Section</u>	<u>Page</u>
5.3 SAMPLE PRESERVATION.....	35
5.4 SAMPLE HOLDING .....	35
5.5 SAMPLE LABELS AND RECORDS.....	35
5.6 SAMPLE SHIPMENT .....	38
6.0 SAMPLE CUSTODY .....	41
6.1 COC RECORD.....	41
6.2 LABORATORY CUSTODY .....	42
6.3 SAMPLE SECURITY, STORAGE AND DISPOSAL.....	43
6.4 SAMPLE TRACKING .....	44
7.0 CALIBRATION PROCEDURES.....	45
7.1 FIELD INSTRUMENTS .....	45
7.1.1 Water-level Measurements.....	45
7.1.2 Headspace Analysis.....	45
7.1.3 pH Measurement.....	45
7.1.4 Electrical Conductivity .....	46
7.1.5 Water Temperature.....	46
7.2 LABORATORY INSTRUMENTS.....	46
7.2.1 Standard/Reagent Preparation.....	46
7.2.2 Gas Chromatography (GC).....	56
7.2.3 Gas Chromatography/Mass Spectroscopy (GC/MS).....	56
7.2.4 Graphite Furnace Atomic Absorption, Cold Vapor Atomic Absorption, and Inductively Coupled Argon Plasma.....	57
7.2.5 Spectrophotometer .....	58
7.2.6 Alpha/Beta Gas Flow Proportional Detector.....	58
8.0 ANALYTICAL PROCEDURES.....	60
8.1 SELECTION OF PARAMETERS.....	60

## TABLE OF CONTENTS (continued)

<u>Section</u>	<u>Page</u>
8.2 SAMPLE PREPARATION.....	60
8.2.1 Organic Preparation.....	60
8.2.2 Metal Preparation .....	60
8.3 REFERENCE MATERIALS.....	66
8.4 ANALYTICAL METHODS .....	66
8.4.1 GC/MS Volatiles.....	66
8.4.2 GC/MS Semivolatiles (Base Neutral Acids).....	67
8.4.3 ICP Metals.....	67
8.4.4 Graphite Furnace Atomic Absorption (GFAA).....	68
8.4.4.1 Arsenic.....	68
8.4.4.2 Lead.....	68
8.4.4.3 Selenium.....	68
8.4.5 Cold Vapor Atomic Absorption (CVAA) - Mercury.....	69
8.4.6 Polychlorinated Biphenyls (PCBs).....	69
8.4.7 Total Petroleum Hydrocarbons.....	69
8.4.8 Gross Alpha/Beta Activity .....	70
9.0 DATA REDUCTION VALIDATION AND REPORTING.....	71
9.1 FIELD MEASUREMENT DATA.....	71
9.2 LABORATORY DATA.....	72
9.2.1 Record Keeping and Review.....	72
9.3 DATA PROCESSING AND COLLECTION.....	72
9.3.1 Validation.....	73
9.3.1.1 Analytical Laboratory Data Review.....	73
9.3.1.2 Data Review Process .....	74
9.3.2 Data Storage .....	74
9.3.3 Transfer .....	74
9.3.4 Reduction .....	74

**TABLE OF CONTENTS**  
**(continued)**

<b><u>Section</u></b>	<b><u>Page</u></b>
10.0 INTERNAL QUALITY CONTROL.....	76
10.1 QUALITY CONTROL SAMPLING.....	76
10.1.1 Trip blanks.....	76
10.1.2 Sampler Rinsate Blanks.....	76
10.1.3 Duplicate Samples.....	76
10.1.4 Background Samples.....	77
10.2 COMPLETENESS.....	77
10.3 QUALITY REVIEW AND REPORT PREPARATION.....	77
10.4 LABORATORY QUALITY CONTROL CHECKS.....	77
10.4.1 Calibration.....	78
10.4.2 System Blanks.....	78
10.4.3 Laboratory Control Samples.....	78
10.4.4 Matrix QC Parameters.....	78
10.4.5 ICP Interference Check Sample.....	78
10.4.6 GC/MS Performance Check.....	79
10.4.7 Sample Container Checks.....	79
10.4.8 Thermometer, Balance, and Refrigerator.....	79
10.4.9 Stationary Blank.....	79
10.4.10 Standard Verification.....	79
10.4.11 Reagent Water.....	80
10.4.12 Reagent Quality Control.....	80
11.0 AUDITS.....	81
11.1 PERFORMANCE AUDITS.....	81
11.2 DOCUMENTATION AND REPORTING AUDITS.....	81
11.2.1 Audit Format.....	81
11.2.2 Distribution of Documentation.....	82

**TABLE OF CONTENTS**  
**(continued)**

<b><u>Section</u></b>	<b><u>Page</u></b>
11.2.3 Follow-up Actions .....	82
11.2.4 Documentation .....	82
12.0 PREVENTIVE MAINTENANCE .....	83
12.1 SYSTEM PERFORMANCE CHECK .....	83
12.2 INSTRUMENT MAINTENANCE .....	83
12.3 INSTRUMENT RUN LOGBOOK .....	84
12.4 INSTRUMENT MAINTENANCE LOGBOOK .....	84
13.0 DATA MANAGEMENT .....	86
14.0 CORRECTIVE ACTIONS .....	87
14.1 LABORATORY CORRECTIVE ACTION .....	87
15.0 QUALITY CONTROL REPORTS .....	89
15.1 FIELD QUALITY CONTROL REPORTS .....	89
15.2 LABORATORY QUALITY CONTROL REPORTS .....	89
15.3 DATA QUALITY ASSESSMENT .....	89
16.0 REFERENCES .....	90

APPENDIX A - Laboratory Data Consultants, Inc. Data Validation Review Process

## LIST OF TABLES

<u>Table</u>		<u>Page</u>
5-1	Sample Containers	33
5-2	Sample Holding Times and Preservatives	37
7-1	Summary of Field Monitoring Equipment Calibration Procedures and Frequencies	47
7-2	QC Level of Effort and Corrective Action for EPA Method 8240	48
7-3	QC Level of Effort and Corrective Action for EPA Method 8270	49
7-4	QC Level of Effort and Corrective Action for EPA Method 8080 (PCBs)	50
7-5	QC Level of Effort and Corrective Action for EPA Method 8015 Modified	51
7-6	QC Level of Effort and Corrective Action for EPA Method 6010	52
7-7	QC Level of Effort and Corrective Action for EPA Method 7000 Series	53
7-8	QC Level of Effort and Corrective Action for EPA Method 7471	54
7-9	QC Level of Effort and Corrective Action for EPA Method 418.1	55
8-1	Analytical Methods and Method Detection Limits	61

## LIST OF FIGURES

<b><u>Figure</u></b>		<b><u>Page</u></b>
2-1	Program QA Organization	3
4-1	Field Boring Log	16
4-2	Generalized Well Construction Diagram	19
4-3	Well Construction Summary	20
4-4	Water Level Measurement Sheet	21
4-5	Well Development Data	23
4-6	Water Quality Field Sampling Data Sheet	24
5-1	Chain-of-Custody	39

## LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	Applicable or Relevant and Appropriate Requirements
BANGF	Bennett Army National Guard Facility
BFB	4-bromofluorobenzene
CCC	Calibration Check Compounds
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain-of-Custody
COR	Contracting Officer's Representative
cpm	Counts per Minute
CVAA	Cold Vapor Atomic Absorption
DFTPP	Decafluorotriphenylphosphene
DOT	Department of Transportation
dpm	Disintegrations per Minute
DQO	Data Quality Objective
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectroscopy
GFAA	Graphite Furnace Atomic Absorption
ICAP	Inductively Coupled Argon Plasma
IRDMIS	Installation Restoration Data Management Information System
IS	Internal Standard
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NIST	National Institute of Standards and Technology
NTAM	Non-USAEC Approved Method

## LIST OF ACRONYMS AND ABBREVIATIONS

(continued)

OD	Outside Diameter
OSWER	Office of Solid Waste and Emergency Response
OVA	Organic Vapor Analyzer
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCBs	Polychlorinated Biphenyls
PCP	Pentachlorophenol
PID	Photoionization Detector
ppb	Parts per Billion
ppm	Parts per Million
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAC	Quality Assurance Coordinator
QC	Quality Control
QC	Quality Control
QCP	Quality Control Plan
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
RRF	Relative Response Factor
RSD	Relative Standard Deviation
SI	Site Inspection
SPCC	System Performance Check Compounds
SVOCs	Semivolatile Organic Compounds
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
VOA	Volatile Organic Analyses
VOCs	Volatile Organic Compounds



## 1.0 PROJECT DESCRIPTION

This Quality Control Plan (QCP) has been developed to support the Site Inspection (SI) at the Bennett Army National Guard Facility (BANGF). The Quality Assurance (QA) Program will ensure that the quality of the data collected during the project is sufficient to support the objectives of the SI. The BANGF, which is a former Titan I missile complex, was recommended for closure under the Base Closure and Realignment Act in 1989. The closure and transfer of this federal facility is subject to the requirements of Section 120 (h) of the Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA). This section requires the evaluation and remediation of hazardous substances which pose a threat to human health or the environment prior to the property transfer.

The SI will be performed to obtain and analyze environmental samples, investigate human and environmental exposure to hazardous substances, and test PA hypotheses that are the basis of the further action conclusion.

The SI sampling program is described in the Bennett Army National Guard Facility Sampling and Analysis Plan. During the program, soil and water samples will be collected for chemical analysis. The policies which are contained in this plan will ensure that:

- Samples are collected using appropriate and documented procedures and are controlled using proper techniques for sample identification, preservation and chain of custody;
- Field measurements and laboratory results are precise and accurate; and
- All activities, findings and results are properly documented.

This plan was developed in accordance with applicable U.S. Environmental Protection Agency (EPA) guidance including *Data Quality Objectives for Remedial Response Activities*, Office of Solid Waste and Emergency Response (OSWER) Directive 933550.7B and *Guidance for Performing Site Inspections Under CERCLA*(Interim Final).

For this QCP, laboratory-specific procedures described are for CKY Analytical Services, a member of the CKY Team for the SI.

## **2.0 QUALITY ASSURANCE ROLES AND RESPONSIBILITY**

The organizational structure of the QA Program for the BANGF SI, illustrated on Figure 2-1, has been designed to ensure that project goals and data quality objectives are met. The contractor Quality Assurance Coordinator (QAC) will manage the QA efforts of the contractor team and serve as the liaison to the United States Army Environmental Center (USAEC) personnel responsible for implementing the QA Program. The roles and responsibilities of key personnel in the QA program are described below.

### **2.1 RESPONSIBILITIES AND AUTHORITY OF USAEC PERSONNEL**

#### **2.1.1 Geology and Chemistry Branch, Installation Restoration Division**

The Geology and Chemistry Branch, Installation Restoration Division will:

- Advise the Commander on quality assurance/quality control (QA/QC) practices;
- Recommend to the Commander QA practices to be used to support USAEC projects;
- Approve Project QC Plans submitted by Contractor Laboratories;
- Provide standardized analytical methods, if available, for specific analytes to Contractor Laboratories;
- Provide analytical reference materials to Contractor Laboratories;
- Review and recommend approval of any proposed modifications to analytical methodology;
- Provide guidance to USAEC Project Officers on implementation of QA/QC in Contractor Laboratories;
- Provide guidance to USAEC Project Officers on chemistry matters;
- Evaluate the quality of data generated by Contractor Laboratories;
- Monitor the effective implementation of QA/QC at Contractor Laboratories and report questionable practices to the Commander of USAEC;
- Conduct on-site audits of Contractor Laboratories;
- Conduct field audits of sampling activities;

USAEC Project Manager
Glen Boldt

CKY Program Manager
Kenneth Shephard

CKY Task Manager (Project Manager)
Anthony Ford

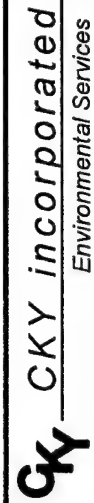
CKY Quality Assurance Coordinator
Tan Phung

CKY Laboratory QA Coordinator
Kevin Hoang

CKY Field Operations Leader
Jay Knight

USAEC Geology and Chemistry Branch
Ivan Sosa - Chemistry
Dennis Bowser - Geology

CKY Data Management Coordinator
Shane Kim



## PROGRAM QA ORGANIZATION

PROJECT NO. 8802

FIGURE 2-1

- Review contractor technical plans for adequacy of analytical methods and QA/QC; and,
- Coordinate data reporting requirements with the USAEC Data Management Group.

Mr. Ivan Sosa will be responsible for all chemistry related matters, and Mr. Dennis Bowser will be responsible for geology related matters for this project.

### **2.1.2 USAEC Project Officer, Base Closure Division**

The Project Officer will, where applicable:

- Act as the principal contact between USAEC and the Prime Contractor;
- Forward Chemistry Branch review comments to the Prime Contractor;
- Discuss proposed changes in approved sampling and analysis procedures with the Chemistry Branch; and
- Provide project QC plans to the Chemistry Branch for review and approval.

Mr. Glen Boldt is the USAEC's Contracting Officer's Representative (COR) for this project.

## **2.2 RESPONSIBILITIES AND AUTHORITY OF THE CONTRACTOR PERSONNEL**

### **2.2.1 Contractor Quality Assurance Coordinator**

The QAC has the responsibility to establish, oversee, and audit specific procedures for documenting and controlling analytical data quality. Many of the procedures will be implemented by other individuals, but the QAC must ensure that procedures are being implemented properly and the results interpreted correctly. CKY's QAC for the USAEC contract is Dr. Tan Phung. Dr. Phung's activities for the BANGF SI will include, but may not be limited to the following:

- Monitor the QA and QC activities of the laboratory to ensure conformance with authorized policies, procedures, and sound practices, and recommend improvements as necessary;
- Inform the Contractor Program Manager, Contractor Analytical Task Manager, and/or contractor laboratory management of nonconformance to the QA Program;

- Ensure that all records, logs, standard procedures, project plans, and analytical results are maintained in a retrievable fashion;
- Ensure that copies of standard procedures, project plans, and standard operating procedures are distributed to all laboratory personnel involved in the project;
- Ensure that sampling is conducted in a manner consistent with the QA Program and other USAEC guidelines. This responsibility includes making unannounced trips to the site to inspect the sampling where applicable. A minimum of coordination with the Contractor Analytical Task Manager prior to the unannounced inspection is acceptable. Each major type of sampling (e.g., ground water, standing water, soil, tank) will be inspected at least once per installation investigation. The QAC will document each inspection and ensure that procedures described in the Sampling and Analysis Plan, Health and Safety Plan, and QCP are followed. The QAC has the authority to require resampling of any site if sample integrity was determined to have been affected by faulty sampling procedures, after obtaining approval from the USAEC Project Officer or the COR;
- Review all laboratory data before those data are transmitted to permanent storage, reported to other project participants, or submitted via the USAEC Installation Restoration Data Management Information System (IRDMIS) as Non-USAEC methods (NTAMS).
- Ensure that a signed Data Package Checklist is included in each completed data package;
- Ensure that all sampling logs, instrument logs, and QC documents are maintained and are completed with the required information;
- Audit sampling documentation and procedures to ensure that samples are labeled, preserved, stored, and transported according to prescribed methods following approved chain-of-custody procedures.

### **2.2.2 Laboratory Analytical Task Manager**

The responsibility for implementing the laboratory QA program resides with the Contractor Analytical Task Manager. Mr. Kevin Hoang will serve as CKY's Analytical Task Manager for the BANGF SI project. Mr. Hoang's responsibilities will include, but may not be limited to the following:

- Through the contractor Project Manager, submit to USAEC Project Officer or Contracting Officer's Representative for approval a detailed Project QC Plan specific to the USAEC project being supported:

- Support a QAC who will not be subordinate to or be in charge of any person having direct responsibility for sampling analyses;
- Provide sufficient equipment, space, resource, and personnel to conduct analyses and implement the project and QA Program;
- Submit the required documentation and laboratory certification data to the USAEC Geology and Chemistry Branch, Installation Restoration Division prior to analyzing field samples;
- Ensure that subsampling and other handling procedures are adequate for the sample types received;
- Oversee the quality of purchased laboratory materials, reagents, and chemicals to ensure that these supplies do not jeopardize the quality of analytical results;
- Ensure implementation of corrective action for any QA/QC deficiencies;
- Establish, with the analysts and the Contractor Analytical Task Manager, the correct analytical lot size, the correct QC samples to be included in each lot, and the correct procedures for evaluating acceptable, in-control analytical performance; and
- Ensure that logging of received samples includes establishing appropriate lot size for each analysis and allocating sample numbers for the correct control samples in each lot and that checklist is filled out and maintained.

### **2.2.3 Contractor Program Manager (Project Director)**

The function of the BANGF program manager is to solve any management, technical or administrative problems that arise during the program and to ensure that the program objectives are met. The program manager will oversee the program to ensure that work is conducted in accordance with QA protocols. The program manager will also allocate to provide adequate QA support. Mr. Kenneth Shepard will serve as the CKY Program Manager for this USAEC contract.

### **2.2.4 Contractor Task Manager (Project Manager)**

The BANGF Task Manager will direct day-to-day project activities. The task manager will supervise field activities and ensure that protocols established in the QCP are adhered to; coordinate activities and schedules with the analytical laboratory and other subcontractors; and resolve QA/QC deficiencies. CKY's Task Manager for the BANGF SI will be Mr. Anthony Ford.

### **2.2.5 Field Operations Leader**

The Field Operations Leader will be responsible for ensuring that technical matters pertaining to the field program are addressed. He will also participate in data interpretation, report writing, and preparation of deliverables and will ensure that work is being conducted as specified in the project workplans. He will ensure that field QA/QC procedures and safety-related protocol are followed. Prior to the start of field work, he will conduct a field staff orientation and briefing to acquaint project personnel with the sites, assign field responsibilities, and provide review of the field operations and equipment. Mr. Knight, a CKY geologist, will be the Field Operations Leader for this project.

### **2.2.6 Data Management Coordinator**

The Data Management Coordinator will be responsible for tracking field and laboratory data using the computerized format of the USAEC IRDMIS. The data will be entered as NTAMS. He will be responsible for all data submitted to IRDMIS and will ensure that all data entered into and residing in IRDMIS exactly correspond to the data contained in the original log books of entry. The Data Management Coordinator for the BANG SI project will be Mr. Shane Kim.

### 3.0 QUALITY ASSURANCE OBJECTIVES

#### 3.1 PROJECT OBJECTIVES AND INTENDED DATA USAGES

The primary objective of the SI is to confirm and identify the presence of contamination at the BANGF. Based on the data obtained during the SI, recommendations for the need for further investigation will be made. To accomplish the SI objectives, data will be collected during the following activities:

- Subsurface soil sampling and analysis
- Groundwater monitoring well installation, sampling, and analysis
- Sampling and analysis of standing water samples from within the underground complex
- Sampling and analysis of product remaining in the tanks within the underground complex.

Data obtained from these activities will be used to confirm the presence or absence of contamination at the site. The objectives of the SI at BANGF require that sufficient data be collected to:

- Confirm the presence or absence of contamination
- Identify the types of contaminants present, if any
- Compare the results with applicable or relevant and appropriate requirements (ARARs) or background concentrations.
- Prepare recommendations for further study (i.e., RI/FS) or no further action.

These data use requirements indicate that the minimum appropriate analytical level for this project will be EPA data quality objective (DQO) Level III.

#### 3.2 DATA QUALITY OBJECTIVES

A comprehensive QA/QC program will be established to ensure that the data produced and information obtained during the BANGF SI accurately represents the environmental conditions that exist at the site. DQOs and specific QC limits and procedures necessary to achieve these DQOs will be established before sample collection can be initiated.

DQOs are quantitative and qualitative and define the quality of data required to support all decisions made during the SI activities at the BANGF. The DQOs were developed following the guidelines presented in the 1987 EPA document *Data Quality Objectives for Remedial Response Activities*, Office of Solid Waste and Emergency Response (OSWER) Directive 933550.7B. The EPA has established the following analytical DQOs for environmental studies: precision, accuracy, representativeness, comparability, and completeness (PARCC).



### 3.2.1 Precision Limits

Precision refers to the level of agreement among repeated measurements of the same characteristic, usually under a given set of conditions. Precision is expressed quantitatively as the measure of variability of a group of measurements compared to their average value. For this project, the precision of the sampling, analytical, and instrument measurement systems will be assessed through the collection and analysis of field duplicate samples and the performance of laboratory analytical replicates and/or matrix spike/matrix spike duplicates.

Precision will be expressed as relative percent difference (RPD), which is calculated according to the following equation:

$$RPD = 100 \frac{(D_1 - D_2)}{(D_1 + D_2)/2}$$

Where: RPD = Relative percent difference  
D<sub>1</sub> = the larger of the two observed values  
D<sub>2</sub> = the smaller of the two observed values.

Duplicate analyses not meeting the precision criteria will undergo the corrective actions described in Section 14.0.

### 3.2.2 Accuracy Limits

Accuracy refers to the degree of agreement of a measurement with an accepted reference or true value. Accuracy is a measure of bias in a measurement system. Sources of error that introduce bias are the sampling process, field contamination, preservation, sample handling, matrix, sample preparation, analysis techniques, and data reduction.

Analytical accuracy will be assessed using standard reference materials, matrix spikes, and surrogate spikes.

Accuracy will be estimated from the analysis of Laboratory Control Samples (LCS) whose true values are known and from surrogate or matrix spike recoveries. Accuracy will be expressed as percent recovery. The formulae to calculate these values are:

For LCS:

$$Accuracy = Percent Recovery = 100 \frac{(Measured Value)}{(True Value)}$$

For Surrogate Spikes:

$$Accuracy = Percent Recovery = 100 \frac{(Measured Value)}{(True Value)}$$

For Matrix Spikes:

$$Accuracy = Percent Recovery = 100 \frac{(C_1 - C_0)}{(C_i)}$$

Where:  $C_0$  = Value of the unspiked aliquot  
 $C_1$  = Value of spiked aliquot  
 $C_i$  = Value for spike added.

Samples not meeting the accuracy criteria will undergo corrective actions as described in Section 14.0.

### 3.2.3 Representativeness

Representativeness is the degree to which data accurately and precisely represent variations at a sampling point or an environmental condition.

To ensure representativeness in the samples being collected for this project, standard sampling techniques as described in Section 4.0 will be strictly adhered to. Any deviations from these techniques will be noted in the field notebook. The field notebooks will be reviewed for deviations in the collection of samples. Additionally, the Site Manager or QA officer will perform field audits to ensure that collected samples are representative of field conditions and standard sampling techniques (sampling, packaging, preservation, etc.) are being utilized for collection of field samples and duplicates in the field.

Representativeness will be insured in the laboratory by strict adherence to standard analysis procedures as described in the laboratory's SOPs. Proper sample storage, analysis, and extraction/digestion techniques will be employed within the required sample holding times. If not specified in the SOPs, the laboratory will establish procedures to ensure that the aliquots used for sample analysis are representative of the whole sample. Representativeness is evaluated by calculating the RPD between field duplicate samples, the quantity and concentrations of all interferences detected in the supporting field QC blanks and laboratory method blanks, and the overall accuracy and precision of the laboratory QC samples. The precision of a representative set of samples reflects the degree of heterogeneity of the sampled medium, as well as the effectiveness of the sampling technique.

### **3.2.4 Comparability**

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same parameters. Comparability will be ensured through the use of standard procedures described in Section 4.0 for sampling and field operations. The same standard procedures and types of sampling equipment will be used throughout this project to increase the comparability of the results.

Data collected in this work effort will be reported as µg/kg or mg/kg.

CKY Laboratories will use SOPs and EPA-approved or equivalent methods for all analyses. Identical analytical methods will be used during the project.

The results for the primary and blind duplicate samples will be used to check the field sampling techniques and the laboratory's precision. The precision will be measured by calculating the RPD for the two values. Additionally, comparability will be measured by the analysis of LCS. The QC results of the LCS will be used to check for accuracy and precision.

### **3.2.5 Completeness**

Completeness will be evaluated qualitatively and quantitatively. The qualitative evaluation of completeness will be determined as a function of all events contributing to the sampling event including items such as correct handling of chain-of-custody forms. The quantitative evaluation of completeness will be defined as the percentage of laboratory-controlled parameters that are acceptable, and will be calculated using the following formula:

$$C=100\frac{V}{T}$$

Where: C = percent completeness  
V = number of measurements judged valid  
T = total number of measurements.

QC parameters that will be assessed for completeness will include surrogate percent recovery, analysis of Matrix Spike/Matrix Spike duplicate analyses for percent recovery and relative percent difference, and analysis of LCS for percent recovery, holding times, and preservation. The goal for the quantitative evaluation of completeness will be 90 percent. The 90 percent standard will be applied to the entire list of parameters described above such that 90 percent of all sample data for a single analytical method are associated with acceptable QC criteria as described above. The goal for holding times is 100 percent. The requirement for holding times will be that if any sample exceeds the holding time specified by EPA SW-846 or other guidance documents that sample will be re-sampled and re-analyzed at the expense of CKY. Data will be screened for contract compliance by the COR. Failure of the analytical data to meet the standards for completeness will result in rejection of data with re-sampling and re-analysis performed at the expense of CKY. Completeness requirements will be applied to data for the project as a whole as well as individual data packages for a single chain-of-custody. Non-conforming data as a result of well-substantiated matrix effects will not be considered in assessing compliance with respect to completeness. In the event of significant occurrence of non-conforming data, CKY will present a summary of data to substantiate an argument for matrix effects to the COR. This data will be reviewed by USAEC. The COR will determine the validity of an argument for matrix effects and instruct CKY as to the necessity of re-sampling/re-analysis.

## **4.0 FIELD PROCEDURES**

Standard procedures for field activities including drilling, soil sampling, well construction, sample collection, field measurements, and decontamination are included in this section. These procedures have been developed in accordance with applicable federal, state, and local requirements. Compliance with these procedures are designed so that representative and comparable data are collected, and samples are collected, labeled, preserved, and transported in a manner that preserves their integrity for their intended purposes.

### **4.1 DRILLING METHODS AND SOIL SAMPLING**

Soil samples for laboratory analysis, lithologic description and/or headspace analyses will be collected during the BANGF SI using a combination of hand auger, hollow stem auger, and air rotary techniques.

#### **4.1.1 Hand Auger Borings**

Shallow soil borings (0 to 5 feet bgs) will be drilled with a 3.5-inch outside diameter (OD) hand auger, if possible. This technique is useful for shallow or surface soil sampling, drilling in areas that are inaccessible to mechanized drill rigs, and drilling in areas that are suspected to contain uncharted or unmarked utilities. Hand-auger drilling uses a stainless steel bucket auger, attached to a rod with a T-shaped handle. Drilling will be accomplished by simultaneously applying downward force and rotating the handle. When the bucket is full, soil cuttings will be removed by withdrawing the bucket auger from the borehole and emptying the contents onto heavy-duty polyethylene sheeting.

Samples can be collected as grab samples from the soil cuttings generated during drilling, or for discrete, undisturbed samples for analysis of volatile compounds, a handdriven hammer sampler will be used. The drive samples will be collected by placing a 6-inch stainless steel sleeve inside the hand auger sampler. The sampler will then be lowered to the bottom of the borehole and advanced into the soil 6 inches with a hand operated slide hammer. The sampler will be withdrawn from the borehole and the sleeve will immediately be removed from the sampler. The ends of the sleeve will be covered with Teflon sheets and plastic end caps. The caps will be secured in place with Teflon tape and the sample will be labeled and placed in an ice chest cooled to  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ .

#### **4.1.2 Hollow-Stem Auger Borings**

Boreholes greater than 5 feet bgs will be drilled using nominal 6-inch OD, continuous flight hollow-stem augers operated from a truck mounted drilling rig. The drill rig will be of sufficient size and capacity to drill borings to a minimum depth of 60 feet bgs. The hollow-stem auger drilling method involves the construction of a borehole by simultaneously rotating and axially advancing the auger column into unconsolidated or poorly consolidated formations. As the augers are rotated and advanced into the ground, they act as a

temporary casing, stabilizing the walls of the borehole. A pilot bit and teeth attached to the end of the lead auger does the drilling and directs the soil cuttings to the auger flights. As the augers are rotated, the cuttings are brought to the surface by the continuous flights on the outside of the hollow stem.

Soil samples will be obtained by attaching a 2.5-inch OD split spoon sampler to a metal rod that will be lowered down the center of the augers. The sampler will contain four 6-inch stainless steel sleeves. The sampler will be driven into the undisturbed soil at the bottom of the borehole a minimum of 18 inches using a 140-pound down hole hammer dropped a distance of 30 inches. The number of hammer blows required to drive the sampler each six inch interval will be recorded to estimate the relative density of the soil. The sampler will be withdrawn from the borehole and opened. The first stainless steel sleeve from the lead end of the sampler will immediately be removed and the ends will be covered with Teflon sheets and plastic end caps. The caps will be secured in place with Teflon tape and the sample will be labeled and placed in an ice chest cooled to  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . Soil from the second sleeve from the lead end of the sampler will be sealed in a wide mouth glass jar for headspace analysis as described in the 4.5.3.

#### **4.1.3 Air Rotary Borings**

A total of five monitoring wells will be installed to estimated depths of 160 feet bgs at the perimeter of the BANGF. A dual wall reverse circulation air rotary drill rig equipped with 10-inch OD augers will be used to drill the boreholes for these monitoring wells. Air rotary drilling is a technique which uses air alone to lift cuttings out of the borehole. A rig-mounted compressor provides a large volume of filtered air which is piped down the drill stem and forced out of the drill bit, cooling the bit and lifting the cuttings. In dryair drilling, the cuttings are blown up the outside of the borehole and collect at the surface. When using this procedure, a surface casing may be required to prevent the borehole from caving or eroding. In reverse air circulation methods, cuttings move up the drill stem and are carried to a centrifugal separate (cyclone). Cuttings are discharged from the bottom of the cyclone into bins or drums, and air exits the top.

Soil samples will be collected from the air rotary borings using techniques similar to those used for the collection of samples from hollow-stem borings. When the appropriate sampling depth is reached, a 2.5-inch OD split spoon sampler containing four 6-inch stainless steel sleeves will be lowered to the bottom of the borehole. The sampler will be driven into the undisturbed soil a minimum of 18 inches using a 140-pound down hole hammer dropped from a distance of 30 inches. Upon retrieval of the sampler, the first stainless steel sleeve from the lead end will immediately be removed and the ends will be covered with Teflon sheets and plastic end caps. The caps will be secured in place with Teflon tape and the sample will be labeled and placed in an ice chest cooled to  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . Soil from the second sleeve from the lead end of the sampler will be sealed in a wide mouth glass jar for headspace analysis.


#### **4.1.4 Borehole Logging**

While the drilling is being performed, the site geologist will record, at a minimum, the following information on a field boring log (Figure 4-1):

- Depths recorded to the tenth foot.
- The estimated interval by depth for each sample taken, classified, and/or retained. For each sample, the length of sample interval and length of sample recovery will be recorded. The sampler type and size (diameter and length) will be recorded.
- Soil classification determined in the field at the time of sampling by the geologist, in accordance with the Unified Soil Classification System. Field soil classification is subject to change based on laboratory test and/or subsequent review. Any such changes will be incorporated in the project report.
- A full lithologic description of each soil sample taken, including a description of all field observations such as the presence of odor, stains, roots, etc.
- The results of the headspace analyses, noting headspace and background reading in parts per million (ppm).
- A record of soil samples selected for laboratory analysis.
- The use of all drilling additives (including water), noting the amount added and the brand name. The source of water for drilling mud must be clean and will be recorded.
- A description of drilling equipment used; including a record of its manufacturer, model number, bit size (corresponding to actual borehole diameter), and auger size.
- A record of the drill sequence and activities.
- A record of all special problems and their solutions; e.g., hole squeezing, recurring problems at a particular depth, or unrecovered tools in the hole.
- The date for the start and completion of borings along with a notation by depth for drill crew shifts and individual days.
- Each sequential boundary between the various soils and individual lithologies, noted by depth. When depths are estimated, the estimated range will be noted along the boundary.

BORING LOCATION				ELEVATION AND DATUM			
DRILLING AGENCY/ DRILLER				DATE STARTED		DATE FINISHED	
DRILLING EQUIPMENT				COMPLETION DEPTH (ft)		DEPTH TO BEDROCK (ft)	
HAMMER WEIGHT/ DROP DISTANCE				DIAMETER OF BORING (in.)		DIAMETER OF WELL (in.)	
TYPE OF WELL CASING			SCREEN PERFORATION		SCREEN INTERVAL (ft)		
TYPE/SIZE OF FILTER PACK			TYPE/THICKNESS OF SEALS				
WATER DEPTH (ft)				LOGGED BY		CHECKED BY	

TIME	PID (ppm)	BLOW COUNT (per foot)	SAMPLE NUMBER	SAMPLE INTERVAL	DEPTH (ft)	LITHOLOGY	WELL CONSTRUCTION	DESCRIPTION OF SUBSURFACE MATERIALS
					5			
					10			
					15			
					20			
					25			
					30			

 <b>CKY incorporated</b> Environmental Services		LOG OF BORING NO.
Project Name:	Project No.:	

Page 1 of

Figure

 **CKY incorporated**  
Environmental Services
**FIELD BORING LOG**

PROJECT NO. 8802

FIGURE 4-1



- The depth of first-encountered free water, along with the method of determination.
- Applicable health and safety monitoring results, such as organic vapors or combustible gas which are present above background level in the borehole.

#### **4.1.5 Soil Sampling**

Samples to be analyzed for chemical constituents may be collected with continuous samplers, drive samplers or hand augers. Stainless steel liners will be used to minimize the potential for cross-contamination between samples due to contact with the sampler. The liners may also serve as containers for samples to avoid the loss of volatile components from the samples. New, precleaned stainless steel liners will be used for each sampling location. After the sampler is removed from the boring, the following procedures will be implemented:

- Liners will be removed from the sampler and marked with a waterproof pen to indicate top and bottom.
- A geologist will examine and log the exposed soil at the end of each stainless steel liner and the soil within those liners which are not submitted for analysis.
- If the sample is to be submitted for laboratory analysis, the liner will be capped with Teflon sheeting and clean, tight-fitting plastic caps that are secured with Teflon tape and labeled.
- Field notes will be recorded in appropriate logbooks in ink.
- Samples for chemical analysis will be stored with ice in coolers for transfer to the off-site laboratory.
- Each sample collected will be recorded on a chain-of-custody record as described in Section 6.0.
- When coolers are ready for transfer to the laboratory, the original chain-of-custody record form will be placed inside a zip-lock bag and taped inside the lid.
- Coolers will be sealed with duct tape and custody seals will be attached.
- If coolers are to be shipped off-site, they will be labeled "Fragile" and "This-End-Up". In addition, coolers will be labeled, if necessary, with appropriate Department of Transportation (DOT) label designations.

## **4.2 MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING**

Five groundwater monitoring wells will be installed at the perimeter of the BANGF. The monitoring wells will be constructed within the borings drilled to estimated depths of 160 feet bgs using reverse circulation air rotary drilling techniques as described in Section 4.1.3.

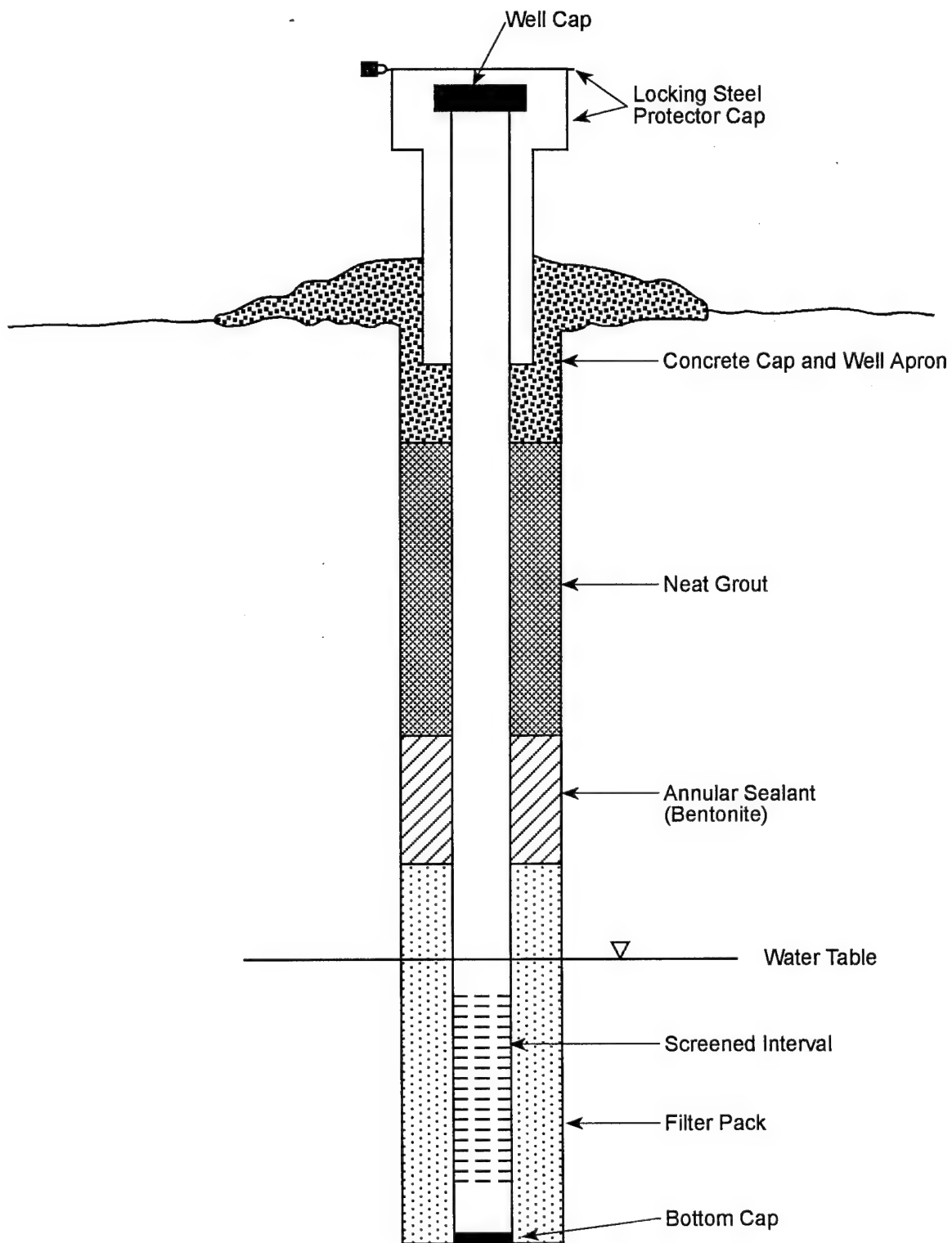
### **4.2.1 Well Construction**

Monitoring wells will be constructed of 4-in OD, flush threaded, Schedule 40, PVC casing. A typical well-construction diagram is presented in Figure 4-2. The final well-construction details will be determined after hydrogeologic conditions are better known. These details include total well depth, screen slot size, screen length, and filter pack material. The Project Manager will approve the well construction details prior to construction of the well. Well completion depth will be decided based on the depth to groundwater and the saturated thickness of the aquifer. Well screen lengths will be determined by the thickness of the saturated interval to be screened. In general, screens will be 20 ft long, with 5 ft above the water table and 15 ft below. Screen slot size will be decided based on field sieve analysis of soil samples. All casing joints will be flush threaded and no solvents or cements will be used on the PVC. Teflon tape may be used as a pipe joint filler, if required. All pipe and screen will be steam-cleaned before use. Wells will be completed above grade and the well head will be encased with an 8-inch steel security casing with a locking lid. Well construction information will be recorded on a well construction summary form (Figure 4-3).

Once the borehole is drilled to the total depth needed, the well will be installed in the annular space within the steel outer casing. The well casing will be suspended off the borehole bottom by a cable on the drilling rig attached to the well head. Stainlesssteel casing centralizers will be placed at the top and bottom of the screen to ensure an even distribution of the filterpack. The filterpack will be placed in the annular space from the base of the well screen to a level 2 to 5 ft above the top of the screen. A bentonite seal, 2 to 5 ft thick and composed of 3/8 to 1/2 in pellets, will be placed above the filterpack and the remaining annular space will be filled with a neat cementbentonite grout. The grout will be well mixed and free of lumps. If the bentonite seal or grout is being placed below the water table it will be pumped to the appropriate level with a tremmie pipe if pellets cannot be used.

### **4.2.2 Well Development**

Prior to well development, the water level and well depth will be measured from a permanently marked point on the well casing using an electric sounding device and weighted tape. The water level will be recorded to the nearest 0.01 inch on the water level form provided in Figure 4-4.



**CKY** *CKY incorporated*  
Environmental Services

**GENERALIZED WELL  
CONSTRUCTION DIAGRAM**

PROJECT NO. 8802

FIGURE 4-2



[illegible]

**CKY** CKY incorporated  
Environmental Services

# WATER LEVEL MEASUREMENT SHEET

PROJECT NO. 8802

**FIGURE 4-4**

Well development will be performed on each of the five wells to remove finegrained material from the well screen, filter pack, and formation near the well, and to evacuate any fluid introduced downhole during drilling or well construction such as drilling mud and fresh water. By removing fine-grained material the porosity and permeability of the nearby formation increases, the filter pack is stabilized, and a hydraulic connection between the well and the aquifer is assured.

Well development will be initiated at least 48 hours and not longer than 7 days after the grout is poured around the well. Well development data will be recorded on the form shown in Figure 4-5. A bailer or pump will be used to develop the well. Water and sediment will be evacuated from the well during development and a swab or the bailer may be used to agitate the water column within the screened interval. The agitation displaces fine material in the well screen and filter pack and allows the material to be removed by additional bailing.

A minimum of five well volumes of water will be removed during development. A volume includes the water standing in the well casing and the saturated annular. Well volume will be calculated using the following formula:

$$WV = (7.48\pi/4) \times [CD^2 + P(BD^2 - CD^2)] \times (WD - GW)$$

where: WV = Well volume (gallons)  
BD = Borehole diameter (ft)  
CD = Casing diameter (ft)  
WD = Well depth  
GW = Depth to groundwater (ft)  
P = Porosity of filter pack

Water levels and well depths will be measured with an electric sounding device. Before development, and at regular intervals during development, measurements of specific conductance, pH, and temperature will be made. Wells will be developed until the water quality parameters have stabilized, and a minimum of five volumes have been removed.

#### **4.2.3 Collection of Groundwater Samples**

Groundwater sampling will be conducted at least 14 days after well development has been completed. Information collected during sampling will be recorded on a water quality sampling form (Figure 4-6). All sampling equipment will be decontaminated before its use in each well as described in Section 4.4.

DEPTH TO BOTTOM (INITIAL) \_\_\_\_\_  
(FINAL) \_\_\_\_\_  
STATIC WATER LEVEL (INITIAL) \_\_\_\_\_  
(FINAL) \_\_\_\_\_  
MEASURING POINT \_\_\_\_\_  
CASING I.D. \_\_\_\_\_  
HYDROGEOLOGIST \_\_\_\_\_  
DRILLER \_\_\_\_\_

PROJECT NO. \_\_\_\_\_

DATE(S) INSTALLED \_\_\_\_\_

DATE(S) DEVELOPED \_\_\_\_\_

PUMP (TYPE) \_\_\_\_\_


CAPACITY \_\_\_\_\_

BAILER (TYPE) \_\_\_\_\_

CAPACITY \_\_\_\_\_

[illegible]

FOPM 14 / JAN 88

 <b>CKY incorporated</b> <i>Environmental Services</i>	
<b>WELL DEVELOPMENT DATA</b>	
<b>PROJECT NO. 8802</b>	<b>FIGURE 4-5</b>





Plastic sheeting will be placed on the ground surrounding the well to prevent contamination of downhole equipment. The water level and total depth of the well will be measured using an electric sounding device, and the height of well casing above ground surface will be measured.

The volume of water standing in the well and the saturated annular will then be calculated as shown in Section 4.2.2. At least five volumes of water will be evacuated from the well using a pump or bailer to ensure that formation water is being sampled. Wells will be purged until the pH, specific conductance, and temperature have stabilized and the required five volumes of water have been removed. Water will be evacuated starting at the top of the water column so that all standing water is removed. If a well becomes dry before five volumes are removed, sampling will be conducted the following day.

Water quality parameters including pH, temperature and specific conductance will be measured periodically during the evacuation. In addition, the dissolved oxygen concentration will be measured if a pump is used. The measurements will be taken at least once for every volume of water removed.

Groundwater samples will be collected from the wells after purging as soon as a sufficient volume of water is present in the well for the intended analyses. Samples will be obtained using a bottom-filling disposable bailer or from a sample port on the pump. Prior to sample collection, bottles will be rinsed 3 times with formation water, except for volatile organic analyses (VOAs). If obtaining sufficient sample volume is difficult, the sample bottles will be single rinsed rather than triple rinsed. After the bottles have been rinsed, a groundwater sample will be collected and dispensed into the appropriate labeled sample bottles. Samples for VOAs will be collected first with as little agitation as possible to prevent loss of the volatile components. Samples collected for metal analysis will be filtered using a .45 micron filter. A prefilter will be used for heavily silted water.

Immediately following collection of groundwater samples for laboratory analyses, a final sample will be collected and tested for pH, temperature and specific conductance. The results will be recorded in the field logbook.

#### **4.2.4 Aquifer Testing**

Aquifer testing will be performed on each of the five wells installed at the site to determine the hydraulic conductivity, transmissivity, and storage coefficient (if possible) of the aquifer under the BANGF. The aquifer tests will consist of slug tests that will be performed after the wells have been developed and the first round of groundwater sampling has been performed.

The slug tests will be performed in two stages. First, in the "falling head test," a mandrel (a weighted, sealed PVC tube) will be rapidly introduced into the well, below the static water level. This action displaces the water surface upward, after which it gradually

equilibrates to its original level. The second stage, or "rising head test," will then be conducted by removing the mandrel, causing a sudden drop, followed by a gradual rise of the water surface. The rate at which the water level in the well returns to its original (static) level is proportional to the hydraulic conductivity of the aquifer materials. Procedures that will be used to conduct these tests are as follows:

- The static water level in the well will be determined by measuring the depth to water periodically for several minutes and taking the average of the readings
- An "instantaneous" change in the volume of water in the well will be created by quickly introducing the weighted, sealed PVC tube into the water column.
- The depth to water will be recorded from the top of the well casing using a pressure transducer connected to a data logger or an electronic depth sounder with a weighted tape. Depth to water measurements will be recorded to the nearest 0.01 foot.
- A watch or other timing device will be used to document the intervals between water-level measurements. The depth to water will initially be measured on an instantaneous basis and then reduced to an interval of 5 to 10 seconds or more for the remainder of the test period.
- The falling head test will be conducted until a minimum of 90 percent of the excess head has dissipated.
- Upon completion of the falling head test, the PVC tube will be quickly removed from the well. The depth to water will be recorded using the procedures described above until a minimum of 90 percent of the head has recovered to the original level.
- The depth to water measurements will be plotted with respect to time. This information will be used to determine the hydrogeologic character of the aquifer.

The data will be analyzed by the Bouwer and Rice Method (Bouwer and Rice, 1976); this method is based upon the Theim equation for steady state flow to a well. The analysis involves a plot of residual head (logarithmic scale) versus time (arithmetic scale). A straight line is applied to the early-time data and used to calculate a value for hydraulic conductivity.

#### **4.3 UNDERGROUND COMPLEX SAMPLING**

Sampling activities within the underground complex will include the collection of standing water samples from each of the missile and antenna silos, the tunnel junction rooms, and beneath the floor in the powerhouse. In addition, samples of any product remaining in the 5,000-gallon diesel tank, the two tanks which are part of the demineralizing system, the RP-1 propellant tank, and the two water-storage tanks will also be collected. The following

sections discuss the procedures that will be used to collect samples within the underground complex.

#### **4.3.1 Standing Water Sampling**

Where possible, standing water samples from the tunnel junction rooms and beneath the powerhouse floor will be collected by holding an appropriate sample container beneath the surface of the water. The containers will be rinsed three times with the standing water, except for the VOAs. For samples requiring chemical preservation, the preservative will be added after the sample bottle is filled.

If the standing water cannot be reached by hand, samples will be collected using a Teflon or stainless steel cup attached to an extension rod. Sampling containers, with the exception of VOAs, will again be rinsed three times with the standing water before a sample is collected for chemical analysis. The samples will then be transferred from the cup to the appropriate labeled bottles. Samples collected for metals analysis will be filtered using a .45 micron filter. A prefilter will be used for heavily silted water.

Samples of the standing water remaining in the missile and antenna silos will be collected using disposable, bottom-filling bailers. The bailer will be lowered to the surface of the water using a braided nylon rope. The bailer will be lowered into, and removed from the water slowly to minimize agitation of the sample. Sample containers, with the exception of the VOAs, will be rinsed three times with water from the sampling location. A sample will then be collected and dispensed into appropriate labeled containers.

#### **4.3.2 Tank Sampling**

If possible, tank samples will be dispensed directly from the tank outlet into appropriate sampling containers. However, based on observations made during the RI/FS facility inspection (Stollar & Associates, et al., 1991), many of the tanks remaining in the complex will have to be sampled through inlet ports. If this is the case, the tanks will be accessed by carefully removing the bolts holding the inlet flanges to the tanks. The flange will then be removed and Teflon lined polyethylene tubing will be lowered to the bottom of the tank. Samples will be siphoned from the tank using a hand operated pump attached to the tubing.

The 5,000-gallon diesel fuel tank will be sampled through an opening located approximately 5 ft from the bottom of the tank, while the RP-1 propellant tank will be sampled through one of several 4-inch flanges that were observed during the facility inspection.

Access to the water storage tanks will be achieved by removing the 4-inch bolted flanges located on the top of each tank. The tank in the air-filtration facility will be accessed by carefully disconnecting the line marked "UA" from the tank. Samples of any liquid remaining in these tanks will be siphoned out, placed in a Teflon or stainless steel cup,

visually inspected, and screened for volatile organic vapor using an organic vapor analyzer (OVA). The pH and conductivity of the liquid will also be measured using field instruments. If field screening indicates that the liquid may not be clean water, a sample for chemical analysis will be siphoned from the tank and dispensed into appropriate sample containers.

The demineralizing system tanks will be accessed by removing lines leading to the tanks and siphoning liquid from the inlet ports. Samples of any liquid remaining in these tanks will be placed in Teflon or stainless steel cups and screened using pH paper. Barium chloride will be added to the samples for identification of sulfuric acid, and silver nitrate will be added for identification of hydrochloric acid. If field screening techniques fail to positively identify the liquids, samples for chemical analysis will be siphoned from the tank and dispensed into appropriate sample containers.

#### **4.4 DECONTAMINATION PROCEDURES**

All equipment that comes into contact with potentially contaminated soil, drilling fluid, water or other materials will be decontaminated prior to and after each use. Decontamination will consist of steam cleaning and distilled water rinses. Equipment will be decontaminated on pallets or plastic sheeting, and clean equipment will be stored on clean plastic sheeting in uncontaminated areas. Materials to be stored more than a few hours will be covered with clean plastic sheeting or stored in plastic bags.

All decontamination waste water will be contained in drums or bulk containers as described in the Sample Design Plan. Samples of the waste water will be analyzed to determine an appropriate disposal mechanism.

##### **4.4.1 Sampling Equipment**

Drilling, sampling, field measurement, and well installation equipment will be decontaminated as follows:

- Drill rigs, auger, drill rods, mud tanks, temporary casing and any other equipment placed in the hole during drilling will be steam-cleaned prior to use and between borings. Visible soil and grease will be removed with a stiff brush.
- Hand augers and other soil sampling equipment will be steam-cleaned or washed with a detergent prior to each use. Stainless steel liners and caps will be cleaned prior to use with a detergent and hot water to remove any residual cutting oils. The liners and caps will then be rinsed with distilled water.
- Casing, screen couplings and caps used in monitoring well installation will be steam-cleaned prior to installation. Visible foreign matter will be removed with a brush. Well casing will be handled with clean gloves during installation.

- The exterior surfaces and accessible interior portions of submersible, centrifugal and bladder pumps will be cleaned with distilled water prior to each use. Inaccessible interior portions of the pumps will be cleaned prior to each use by purging water through the pump and discharge lines. Every effort will be made to sample the wells in the order of the least to most contaminated to minimize further the risk of sample cross-contamination.
- The stainless steel or Teflon bailer used for collection of the ground-water samples will be cleaned at the start of the job and between wells as follows:
  - Scrub equipment with solution of laboratory grade detergent (Alconox) using brush.
  - Rinse equipment with water from USAEC-approved source.
  - Rinse equipment with ASTM water.
  - Rinse equipment with isopropanol and air dry.
  - Rinse equipment with ASTM water again, air dry, wrap in aluminum foil.
- Steel tapes, water probes, transducers, thermometers and water-quality meter probes will be rinsed in distilled water or cleaned in a detergent solution between wells.

To the extent practical, all cleaning shall be performed in an area that is remote from and surficially cross-gradient or downgradient from any site to be sampled. All decontamination will be done by personnel in protective gear appropriate for the level of decontamination, as determined by the Health and Safety Officer.

#### **4.4.2 Monitoring Equipment**

Monitoring equipment will be protected as much as possible from contamination by draping, masking, or otherwise covering as much of the instruments as possible with plastic without hindering the operation of the unit. The OVA, for example, can be placed in a clear plastic bag which allows reading of the scale and operation of the controls. The OVA can be partially wrapped, keeping the sensor tip and discharge port clear.

The contaminated equipment will be taken from the drop area and the protective coverings removed and disposed of in the appropriate containers. Any direct or obvious contamination will be brushed or wiped with a disposable paper wipe. The units can then be taken inside in a clean plastic tub, wiped off with damp disposable wipes, and dried. The units will be checked, standardized, and recharged as necessary for the next day's operation. They will then be prepared with new protective coverings.

#### **4.4.3 Respirators**

Respirators will be decontaminated daily. Taken from drop areas, the masks will be disassembled, the cartridges set aside, and the rest placed in a cleansing solution. After an appropriate time within the solution, the parts will be removed and rinsed with tap water. Personnel will inspect their own masks to be sure of proper readjustment of straps for proper fit.

#### **4.5 FIELD MEASUREMENTS**

Field data will be collected during various sampling and monitoring activities at BANGF. This section describes routine procedures to be followed by personnel performing field measurements. The methods presented below are intended to ensure that field measurements are consistent and reproducible when performed by various individuals. Field personnel will record field measurements on standardized logs. In addition to properly recording data on these forms, personnel will maintain field notebooks in which data will be recorded.

The calibration and precision requirements for field measurements are discussed in Section 7.0 The types of field measurements to be made at the site include:

- Water-level measurements in wells to establish vertical and horizontal hydraulic gradients during well installation, purging and prior to sampling.
- Conductivity, temperature, dissolved oxygen and pH measurements made on groundwater samples during pumping, well purging and sampling.
- Volatile organic vapor analysis of ambient air quality and soil sample headspace using an organic vapor analyzer.

Procedures for each of these measurements are presented below.

##### **4.5.1 Water-level Measurements**

Water level may be measured using a steel tape, electric probe and/or pressure transducer. If a pump or other equipment is in the well, measurement devices will be lowered slowly to avoid entanglements. Water-level measurements in completed wells will be made from a permanently marked reference point on the well casing. The elevation of this point will be established by survey and referenced to mean sea level. Water levels measured in boreholes or wells during construction will be made relative to the ground surface. Measurements will be made and recorded to the nearest hundredth of a foot on a Water Level Measurement Sheet (Figure 44). In general, water-level measurements to determine hydraulic gradients, and in some permeability or aquifer test, will be made with an electric probe. A steel tape may also substitute for the electric probe.

#### **4.5.2 Conductivity, Temperature, and pH Measurements**

Electrical conductivity, water temperature, and pH measurements will be made in the field during purging, before each water sample collection and during well development. The water sample will be placed in a bottle or jar used solely for field testing. A field pH meter with a combination electrode or equivalent will be used for pH measurements. Temperature measurements will be performed using standard thermometers or equivalent temperature meters. Combination instruments capable of measuring two or all three of the parameters may also be used.

All instruments will be calibrated as described in Section 7.0. If conductivity standards or pH buffers are used in field calibration, their values will be recorded in the field notebook. The sample-testing bottle and all probes will be cleaned and rinsed with distilled water prior to any measurements.

#### **4.5.3 Headspace Analyses**

Volatile organic vapor present in the headspace of soil samples will be measured using an OVA. These measurements will be obtained from soil samples in the following manner:

- A portion of the soil sample collected will be placed in a clean wide mouth glass jar;
- The jar will be sealed with Teflon film, or aluminum foil, capped and labeled;
- The samples will be allowed to sit for at least 15 minutes so soil gases can equilibrate with the air in the headspace of the jars;
- The headspace will be tested for volatile organic vapors with an OVA; and
- Headspace and background readings will be recorded in ppm and incorporated into boring logs.



## **5.0 SAMPLE COLLECTION AND MANAGEMENT**

The quality of sample collection and management techniques must be assured by keying the technique used to both the medium/matrix to be sampled and the analytes of interest. For example, water samples intended for semivolatile organic compound (SVOC) analysis are collected in amber glass bottles; water samples for volatile organic compound (VOC) analysis are collected in Teflon-septum-capped 40-ml glass vials with "zero" headspace to minimize diffusive and evaporative losses; and samples for metal analyses are collected in polyethylene bottles. Acquisition of environmental samples requires specialized collection techniques to preserve integrity and ensure that a representative portion of the source is collected. Further, unless the proper sample bottle preparation and sample preservation measures are taken in the field, sample composition can be altered by introducing contamination, degradation, biological transformation, chemical interactions, and other factors during the time between sample collection and analysis. Sample management and record keeping are key elements in the documentation of environmental measurements and are essential to an effective sampling QA program.

### **5.1 SAMPLING SITES**

The rationale for each sampling site location is identified in the Sampling and Analysis Plan. To permit proper evaluation of the analytical results, it is important that the actual location of the samples be properly documented. Sampling sites will be marked in the field with stakes or flags. All monitoring well locations will be accurately referenced on a base map for entry into the IRDMS Map File (GMA). Horizontal accuracy will be within +3.0 vertical accuracy to within +0.05 feet. Photographs of sampling sites are taken as necessary to document site conditions.

### **5.2 SAMPLE CONTAINERS**

To ensure the integrity of aqueous and soil samples, steps will be taken to minimize contamination from the containers in which they are stored. For aqueous samples, if the analyte(s) to be determined are organic in nature, the container will be made of amber glass. If the analyte(s) are inorganic, the container will be polyethylene. When both organic and inorganic substances are expected to be present, separate samples will be taken. Stainless steel sleeves (tubes) will be used to contain soil samples for both organic and metal analysis. New sample bottles and tubes will be used for each sample.

Aqueous and soil samples will be collected in the following containers as listed on Table 5-1.



Table 5-1 Sample Containers

Parameter	Water	Soil
1. Volatile Organic Compounds	Amber glass VOA vials w/Teflon septum	Sampler Tube or 8 oz wide mouth glass jars
2. Semivolatile Organic Compounds	Amber glass w/Teflon cap	Sampler Tube or 8 oz wide mouth glass jars
3. Metals	Polyethylene bottle w/Teflon cap	Sampler Tube or 8 oz wide mouth glass jars
4. Anions	Polyethylene bottle w/Teflon cap	Sampler Tube or 8 oz wide mouth glass jars
5. Total Petroleum Hydrocarbons	Glass w/Teflon cap	Sampler Tube or 8 oz wide mouth glass jars
6. Gross Alpha/Beta	Plastic Cubitainer	-----
7. Polychlorinated Biphenyls (PCBs)	-----	Sampler Tube or 8 oz wide mouth glass jars

### **5.2.1 Precleaned Sample Containers**

Precleaned sample containers will be supplied by the laboratory. The laboratory will purchase precleaned containers from a laboratory supplier. The supplier will preclean the container as follows:

#### **5.2.1.1 Amber Glass Bottles and Wide-Mouth, Clear Glass Jars**

1. Wash the containers, closures, and Teflon liners in hot tap water with a laboratory grade non-phosphate detergent.
2. Rinse three times with tap water.
3. Rinse one time with a 1:1 mixture of nitric acid and deionized water.
4. Rinse three times with ASTM Type I deionized water.
5. Rinse one time with pesticide-grade methylene chloride.
6. Oven dry containers, closures, and liners.
7. Remove containers, closures, and Teflon liners from oven.
8. Place Teflon liners in closures and place closures on container. Attendant will wear gloves and the containers will not be removed from the preparation room until sealed.

#### **5.2.1.2 40 ml Borosilicate Glass Vials**

1. Wash the containers, septa or liners, closures in hot tap water with a laboratory-grade non-phosphate detergent.
2. Rinse three times with tap water.
3. Rinse three times with ASTM Type I deionized water.
4. Oven dry containers, septa or liners, and closures.
5. Remove containers, septa or liners, and closures from the oven.
6. Place liners in closures, Teflon side down, and place closures on containers. Attendant will wear gloves and the containers will not be removed from the preparation room until sealed.

### **5.2.1.3 Polyethylene Bottles**

1. Wash the containers, closure, and Teflon liners in hot tap water with a laboratory-grade, non-phosphate detergent.
2. Rinse three times with tap water.
3. Rinse one time with a 1:1 mixture of nitric acid and deionized water
4. Rinse three times with ASTM Type I deionized water.
5. Air dry in contaminant-free environment.
6. Place liners in closures and place closures on containers. Attendant will wear gloves and the containers will not be removed from preparation room until sealed.

## **5.3 SAMPLE PRESERVATION**

It is important to maintain the integrity of the samples from the time of collection until the analyses are performed. Before transportation and storage of the sample, it will be preserved using the preservation techniques and procedures recommended by USAEC and the EPA (see Table 5-2).

Sample preservation will be performed in the field by a qualified technician trained in the preservation techniques for inorganic and organic compounds.

## **5.4 SAMPLE HOLDING**

The time that a preserved sample may be held between sampling and analysis is based on the stability of the analyte(s) of interest. Holding time limitations are intended to minimize chemical change in a sample before it is analyzed. Results reported for samples analyzed after holding times have been exceeded will be considered out of control and unacceptable. To expedite analysis and to minimize the possibility of exceeding holding times, samples must be sent to the laboratory by a fast, reliable method as soon as possible after collection. Table 5-2 summarizes allowable holding times for each analysis and sample matrix. In general, all samples shipped from the field will be maintained at 4°C and retained in the laboratory at 4°C.

## **5.5 SAMPLE LABELS AND RECORDS**

Field sampling personnel will maintain bound field logbooks and will record at the minimum the information identified below:

- Boring or well identification number;
- Sample identification numbers;
- Sample collection date and time;
- Sample matrix;
- Boring/well depth;
- Sampler's name;
- Sample appearance, note any unusual staining or coloration and odor (if possible);
- Sample field measurements including static water level, pH, temperature, and electrical conductivity (if applicable);
- Type of sample equipment and method used;
- Type and number of sample containers;
- Decontamination procedures;
- Purging methods, purge volume, pumping rate, and purging time period (if applicable);
- Weather conditions including ambient temperature;
- Field observations of the sampling event and other notable occurrences and the time of occurrences;
- Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample;
- Analyses to be performed on the sample; and
- Method of sample shipment.

Some of the information listed above is recorded on specific forms associated with sample acquisition. These forms will not be included in the bound field notebook, but will instead be kept with the project file.

An adhesive, waterproof sample label will be affixed to each individual sample collected. The following information will be recorded with a waterproof marker on each label.

Table 5-2 Sample Holding Times and Preservatives

Parameter	Preservative		Analytical Method	Maximum Holding Times
	Water	Soil		
Metals				
-Al	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Sb	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Ba	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Be	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Cd	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Ca	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Cr	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Co	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Cu	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Fe	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Mg	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Na	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-K	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Mn	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Mo	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Ni	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Ag	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Ti	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Vi	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-Zn	HNO <sub>3</sub> to pH < 2	Cool to 4°C	ICP	180 days
-As	HNO <sub>3</sub> to pH < 2	Cool to 4°C	GFAA	180 days
-Se	HNO <sub>3</sub> to pH < 2	Cool to 4°C	GFAA	180 days
-Pb	HNO <sub>3</sub> to pH < 2	Cool to 4°C	GFAA	180 days
-Hg	HNO <sub>3</sub> to pH < 2	Cool to 4°C	CVAA	28 days
PCBs	-----	Cool to 4°C	GC/EC	7 days until extraction 40 days after extraction
Volatile Organic Compounds	Cool to 4°C	Cool to 4°C	GC/MS	14 days until extraction
Semivolatile Organic Compounds	Cool to 4°C	Cool to 4°C	GC/MS	7 days until extraction 40 days after extraction
Total Petroleum Hydrocarbons	Cool to 4°C HCL to pH < 2	Cool to 4°C	IR	7 days until extraction 30 days after extraction
Gross Alpha/Beta	HNO <sub>3</sub> to pH < 2	-----	Proportional Detector	180 days

ICP - Inductively Coupled Plasma

GFAA - Graphite Furnace Atomic Absorption

CVAA - Cold Vapor Atomic Absorption

GC - Gas Chromatography

EC - Electron Capture

MS - Mass Spectrometry

IC = IR - Infrared Spectrophotometer

- Project name and location;
- Project number;
- Unique chronological sample identification number;
- Sample location and depth;
- Sample type;
- Date and time of collection;
- Sampler's initials;
- Analyses to be performed on the sample; and
- Sample preservation (if any).

## **5.6 SAMPLE SHIPMENT**

The following discussion outlines generic procedures for shipment of samples.

- A member of the field team will be designated Sample Coordinator. The Sample Coordinator will place the sample in a plastic ice chest with appropriate preservation material tightly packed with suitable packing material. The original chain-of-custody (COC) form will be signed, dated, and the time recorded by the Sample Coordinator prior to transferring custody for shipment. Figure 5-1 shows a copy of the COC form. A notation will be made in the remarks section of the record indicating method of shipment, courier's name, and other pertinent information. The COC will be sealed in an envelope and a custody seal will be placed on the envelope flap. The envelope will be taped to the inside of the ice chest with the name and address of the receiving laboratory prominently displayed. The ice chest will be taken directly to the shipping agent by the Sample Coordinator and custody relinquished to the shipping agent.
- The Sample Coordinator will close and seal the ice chest with a custody seal. The Sample Coordinator will fill out the custody seal as described above with the exception that the sample number will not be necessary when several samples are placed in each ice chest. The seal will be attached to the ice chest in such a way that it will be necessary to break it to open the ice chest. All custody seal must be applied to sample containers and ice chests by the Sample Coordinator. The ice chest will be taped closed by wrapping each end at least twice with either fiberglass-reinforced tape or a strong adhesive tape. Paper tape or "Scotch" tape will not be allowed.

# CHAIN OF CUSTODY RECORD REQUEST FOR ANALYSIS

**CKY**  
CKY Incorporated  
Analytical Laboratories  
630 Maple Ave.  
Torrance, Calif. 90503  
Tel: 310-618-8889  
Fax: 310-618-0818

CLIENT NAME: \_\_\_\_\_  
ADDRESS: \_\_\_\_\_  
PHONE NO. \_\_\_\_\_ FAX NO. \_\_\_\_\_  
PROJECT NAME: \_\_\_\_\_  
SEND REPORT TO: \_\_\_\_\_

DATE: \_\_\_\_\_  
PAGE \_\_\_\_\_ OF \_\_\_\_\_

SAMPLER NAME/SIGNATURE \_\_\_\_\_

TURN AROUND TIME

NORMAL ☐  
RUSH ☐

ANALYSES REQUIRED

418.1  
M8015  
8010/601  
8020/602  
8080/608  
8240/624  
8270/625  
CAM Metals

SAMPLE DESCRIPTION  
WATER SOIL OTHER

CONTAINER  
SIZE/TYPE

PRESER-  
VATIVE

SAMPLING  
DATE/TIME

SAMPLE  
NUMBER

COMMENTS:

Relinquished by: (Signature)	Date:	Received by: (Signature)	Date:
Company:	Time:	Company:	Time:

Storage/Disposal of Samples: Sample will be stored at CKY for 30 days at no charge and at \$10/sample/month thereafter. Disposal of sample by the Laboratory will be charged at \$10/sample.

**CKY** CKY incorporated  
Environmental Services

CHAIN-OF-CUSTODY FORM

PROJECT NO. 8802

FIGURE 5-1

- The sample coordinator will inform the laboratory by telephone that the samples have been shipped and will arrive during working hours the following day.



## 6.0 SAMPLE CUSTODY

### 6.1 COC RECORD

The SI Contractor will establish a program of sample tracking and COC that is followed during sample handling activities in both field and laboratory operations. This program, which is compatible with USAEC and EPA COC programs, is designed to assure that each sample is accounted for at all times.

The objective of the sample custody identification and control system is to ensure, to the extent practicable, that:

- All samples scheduled for collection, as appropriate for the data required, are uniquely identified;
- The correct samples are analyzed and are traceable to their records;
- Important sample characteristics are preserved;
- Samples are protected from loss or damage;
- Any alteration of samples (e.g., filtration and preservation) is documented;
- A forensic record of sample integrity is established;
- Legally traceable custody and possession records are maintained; and
- Sample security is maintained.

The COC protocol followed by the sampling crews involves the following steps:

- Documenting procedures and amounts of reagents or supplies (e.g., filters) which become an integral part of the sample from sample preparation and preservation;
- Recording sampling locations, sample bottle identification, and specific sample acquisition measures on the appropriate forms;
- Using preprinted sample labels to document all information necessary for effective sample tracking; and
- Completing standard field data record forms to establish sample custody in the field before sample shipment.

The COC record contains the following information:

- The sample number, sample bottle identification number, preservation, and sample type;
- The names of the sampler(s) and the person shipping the samples;
- Pertinent field data;
- The date and time that the samples were delivered for shipping;
- Analyses required; and
- The names of those responsible for receiving the samples at the laboratory.

The COC form is completed in triplicate. The original will accompany the samples to the laboratory, another is kept by the sample crew and transferred to the contractor QAC, and the last copy is maintained in the project file.

Color slides or photographs may be taken of the sample locations to facilitate identification and later recollection by the sampler. A photograph log will be maintained and will include the signature of the photographer, time, date, site location, and brief description of the subject of the photograph. Photographs and written records, which may be used as evidence, are handled in such a way that COC can be established.

## **6.2 LABORATORY CUSTODY**

COC procedures are also necessary in the laboratory from the time of sample receipt to the time the sample is discarded. The following procedures will be implemented by the laboratory:

- All incoming samples will be received by the sample custodian, who will indicate receipt by signing the accompanying custody forms and who will retain the signed forms as permanent records. The samples are checked at the time of receipt for any problems that may have occurred during shipping or discrepancies with the COC record. All problems are immediately reported to the field operations leader.
- The sample custodian maintains a permanent logbook to record, for each sample, the person delivering the sample, the person receiving the sample, the date and time received, the source of the sample, the sample identification or log number, how the sample was transmitted to the laboratory, and the condition received (i.e., sealed, unsealed, broken container, or other pertinent remarks).

- A clean, dry, isolation room, building, and/or refrigerated space that can be securely locked from the outside will be designated as a "Sample Storage Security Area".
- The custodian ensures that heat-sensitive, light-sensitive, radioactive, or other samples having unusual physical characteristics or requiring special handling, are properly stored and maintained prior to analysis.
- Distribution of samples to individuals who are responsible for the laboratory performing the analysis is made only by the custodian.
- Laboratory personnel are responsible for the care and custody of the sample once it is received by them. They will sign the COC and will be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received from the custodian until the time that the analyses are completed.
- Once the sample analyses are completed, the unused portion of the sample, together with all identifying labels, is returned to the custodian. The returned tagged sample is retained in the custody room until permission to destroy the sample is received by the custodian.
- Sample will be destroyed only upon the order of the Task Manager, in consultation with the USAEC COR. This only occurs after elevation of chemical data into the IRDMS Level 3.

### **6.3 SAMPLE SECURITY, STORAGE AND DISPOSAL**

CKY Analytical Services is locked except during the regular business day between the hours of 7:30 a.m. and 5:30 p.m. Admittance to the building during nonbusiness hours is available through coded personnel identification cards. Nonemployees are required to sign the visitor register upon admittance and are escorted at all times. Nonemployees are not permitted in the laboratory during nonbusiness hours.

To facilitate the proper storage of samples after receipt and prior to the initiation of analysis, CKY Laboratories maintains secured walk-in refrigerators as well as freezers and other secured sample storage areas. All samples requiring special storage conditions (e.g., cold, frozen) are stored in accordance with specifications.

#### **6.4 SAMPLE TRACKING**

After sample receipt and the accompanying required documentation of the COC record is completed, CKY Laboratories reference numbers are assigned and a DCL Work Order is generated. Samples are then split as required. The splits are recorded on the COC and appropriate copies of all paperwork are generated. Sample information is then entered into the computer based logbook, then verified by a second entry. Samples are assigned by the Technical Operations Section Managers to appropriate analytical or extraction personnel. Samples, splits and extracts are maintained under COC at all stages of analysis through final sample storage following analysis.

## **7.0 CALIBRATION PROCEDURES**

Procedures described in this section pertain to the calibration of equipment and instrumentation in the field and in the laboratory. The procedures reference standard operating procedures, when available, and specify calibration frequency and standards. All calibrations for field and laboratory equipment will be recorded in appropriate log books and/or forms.

### **7.1 FIELD INSTRUMENTS**

Procedures described in this section pertain to the calibration of equipment and instrumentation that will be used during the BANGF SI field investigation. All field equipment will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. All calibrations for field equipment will be recorded in appropriate log books and/or forms.

Field instruments which will require calibration include instruments for measuring water levels, headspace analysis, pH, conductivity, and temperature.

#### **7.1.1 Water-level Measurements**

The following are calibration methods that may be applied for various water-level measuring devices which may be utilized for this project.

- Electrical probe calibration: Check against steel surveyor's tape prior to use;
- Graduated steel tape calibration: Manufacturersupplied temperature correction will be applied if applicable for field conditions; and
- Pressure transducer calibration: Factory calibrated once, field calibration check with water columns prior to permeability or aquifer tests, and periodic field checks against steel tape or electrical probe during longterm monitoring or testing.

#### **7.1.2 Headspace Analysis**

OVA used for headspace analysis will be calibrated daily to methane before field use, as specified by the manufacturer. Photoionization Detectors (PIDs) will be calibrated daily to isobutylene prior to field use, as specified by the manufacturer.

#### **7.1.3 pH Measurement**

Digital pH meter calibration: Calibration checked before each field use. Laboratory-supplied buffer solutions will be renewed daily in the field, and used periodically between measurements. Temperature corrections will be applied during measurement.

#### **7.1.4 Electrical Conductivity**

Electrical conductivity meter calibration: Calibrated before each field use. Temperature correction may be applied automatically by instrument during measurement.

#### **7.1.5 Water Temperature**

Mercury thermometer calibration: Factory calibrated once against U.S. Bureau Standards, and checked at least annually.

Temperature meter calibration: Calibrated weekly against mercury thermometer.

Suggested calibration procedures and precision requirements for field measurement are summarized in Table 7-1.

### **7.2 LABORATORY INSTRUMENTS**

The laboratory instruments used during the analysis of samples will be calibrated according to and at the frequency indicated by the specific analytical methods used. Calibration procedures and frequencies, as well as corrective action for each of the analytical methods that will be used for this project are included in Tables 7-2 through 7-9. These analytical methods are discussed in Section 8.4. All instruments will be calibrated through the use of standard solutions of known concentrations. Calibration will be continuously verified by analysis of these calibration standards or laboratory control samples at regular intervals. Calibration will be performed at specified time intervals or when continuous calibration verification procedures indicate the need.

#### **7.2.1 Standard/Reagent Preparation**

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. To ensure the highest purity possible, all primary reference standards and standard solutions will be obtained from the National Institute of Standards and Technology (NIST), or other reliable commercial sources. All standards and standard solutions are logged into a database that identifies the supplier, lot number, purity/concentration, receipt preparation data, preparer's name, method of preparation, expiration date, and all other pertinent information.

**Table 7-1 Summary of Field Monitoring Equipment  
Calibration Procedures and Frequencies**

Equipment	Use	Calibration Procedures	Unit of Measure
Organic Vapor Analyzer	Air Monitoring during field investigation for presence of organic vapors. Headspace analysis.	Calibrate daily using 100 ppm methane calibration gas.	Parts per million
Microtip PID	Air Monitoring during field investigation for presence of organic vapors. Headspace analysis.	Calibrate daily using 100 ppm isobutylene calibration gas.	Parts per million
Electrical Probe	Water level measurement.	Check against steel surveyor's tape before use.	Feet
Steel Surveyor's Tape	Water level measurement.	Check against new steel surveyor's tape before use.	Feet
Pressure Transducer	Water level measurement.	Periodically check against steel surveyor's tape or electrical probe.	Feet
pH Meter	Measure groundwater pH during purging and sampling of monitoring wells.	Calibrate before each use with laboratory-supplied buffer solution.	Standard units
Electrical Conductivity Meter	Measure groundwater electrical conductivity during purging and sampling of monitoring wells.	Calibrate daily using conductivity calibration solution (potassium chloride, water, and 0.002 percent iodine).	Micromhos per centimeter
Mercury Thermometer	Measure groundwater temperature during purging and sampling of monitoring wells.	Factory calibrated against U.S. Bureau Standards. Check annually against NIST-certified thermometer.	Degrees Celsius
Temperature Meter	Measure groundwater temperature during purging and sampling of monitoring wells.	Calibrated weekly against a mercury thermometer.	Degrees Celsius
Oxygen Meter	Measure oxygen content of the air in the underground complex during sampling activities.	Calibrated bimonthly with ambient air	% O <sup>2</sup> by Volume
Hydrogen Sulfide Meter	Evaluation of the atmosphere in the underground complex.	Calibrated bimonthly with 90 ppm H <sub>2</sub> S	Parts per million
Combustible Gas Indicator	Used to monitor potential explosive atmospheres during sampling activities in the underground complex.	Calibrated bimonthly with standard calibration gas (30% methane).	% LEL

Table 7-2 QC Level of Effort and Corrective Action for EPA Method 8240

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action																																			
BFB Tune	12 hours	Table 3/8240 - SW846	Re-run before sample analysis																																			
5 pt. Initial Calibration	Initially/as needed	RSD of CCC < 30% RRF of SPCC > / = 0.3	Re-calibrate before sample analysis																																			
Continuing Calibration	12 hours	%D of CCC < 25% RRF of SPCC > = 0.3 (0.25 for Bromoform)	Recalibrate and reanalyze last sample group affected																																			
Method Blank	Ech day, before any samples	No target compounds should be above method detection limit (MDL)	Stop analysis, correct problem, reanalyze all affected samples																																			
Matrix Spike/Matrix Spike Duplicate	Each batch ( < = 20)	<table><thead><tr><th></th><th colspan="2">Soil</th><th colspan="2">Water</th></tr><tr><th></th><th>% R</th><th>RPD</th><th>% R</th><th>RPD</th></tr></thead><tbody><tr><td>1,1-DCE</td><td>59-172</td><td>22</td><td>61-145</td><td>14</td></tr><tr><td>TCE</td><td>62-137</td><td>24</td><td>71-120</td><td>14</td></tr><tr><td>Benzene</td><td>66-142</td><td>21</td><td>76-127</td><td>11</td></tr><tr><td>Toluene</td><td>59-139</td><td>21</td><td>75-130</td><td>13</td></tr><tr><td>Chlorobenzene</td><td>60-133</td><td>21</td><td>75-130</td><td>13</td></tr></tbody></table>		Soil		Water			% R	RPD	% R	RPD	1,1-DCE	59-172	22	61-145	14	TCE	62-137	24	71-120	14	Benzene	66-142	21	76-127	11	Toluene	59-139	21	75-130	13	Chlorobenzene	60-133	21	75-130	13	Reanalyze MS/MSD pair
	Soil		Water																																			
	% R	RPD	% R	RPD																																		
1,1-DCE	59-172	22	61-145	14																																		
TCE	62-137	24	71-120	14																																		
Benzene	66-142	21	76-127	11																																		
Toluene	59-139	21	75-130	13																																		
Chlorobenzene	60-133	21	75-130	13																																		
Laboratory Control Sample (Blank Spike)	Each batch ( < = 20)	65-135%	Re-analyze LCS and batch of samples																																			
Surrogate Recovery	Each sample	1,2-Dichloroethane-d4: 70-121 (S), 76-114 (W) Toluene-d8: 81-117 (S), 88-110 (W) Bromofluorobenzene: 74-121 (S), 86-115 (W)	Repeat sample once. If still outside limits, matrix interference is suspected																																			
Calibration Check Standard	Whenever initial calibration is run.	All +/- 10% D except acetone, butanone, dichloro difluoro methane, chloro methane, and trichlorofluoro methane, D < / = 30%	Repeat calibration, if it still fails, pick up new standard and reanalyze until pass.																																			



Table 7-3 QC Level of Effort and Corrective Action for EPA Method 8270

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action																																																																	
DFTPP Tune	12 Hours	Table 3/8270-SW846	Re-run before sample analysis																																																																	
5 pt. Initial Calibration	Initially/as needed	RSD of CCC < 30% RRF of SPCC > = 0.05	Re-calibrate before sample analysis																																																																	
Continuing Calibration	12 Hours	%D of CCC < 25% RRF of SPCC > = 0.05	Re-calibrate and re-analyze last sample group affected																																																																	
Method Blank	Each batch	No target compounds above MDL except phthalates (conc. 5X project specific detection limit)	Stop analysis, correct problem, and re-analyze. If problem persists, re-extract all associated samples																																																																	
Matrix Spike/Matrix Spike	Each batch(< = 20)	<table><tr><td>Acceptance Criteria:</td><td colspan="2">Water</td><td colspan="2">Soil</td></tr><tr><td></td><td>% R</td><td>RPD</td><td>% R</td><td>RPD</td></tr><tr><td>Phenol</td><td>12-110</td><td>42</td><td>26-90</td><td>35</td></tr><tr><td>2-Chlorophenol</td><td>27-123</td><td>40</td><td>25-102</td><td>50</td></tr><tr><td>1,4-DCB</td><td>36-97</td><td>28</td><td>28-104</td><td>27</td></tr><tr><td>N-Nitroso-di-n propylamine</td><td>41-116</td><td>38</td><td>41-126</td><td>38</td></tr><tr><td>1,2,4-Trichlorobenzene</td><td>39-98</td><td>28</td><td>38-107</td><td>23</td></tr><tr><td>4-Chloro-3-methylphenol</td><td>23-97</td><td>42</td><td>26-103</td><td>33</td></tr><tr><td>Acenaphthene</td><td>46-118</td><td>31</td><td>31-137</td><td>19</td></tr><tr><td>4-Nitrophenol</td><td>10-80</td><td>50</td><td>11-114</td><td>50</td></tr><tr><td>2,4-Dinitrotoluene</td><td>24-96</td><td>38</td><td>28-89</td><td>47</td></tr><tr><td>Pentachlorophenol</td><td>9-103</td><td>50</td><td>17-109</td><td>47</td></tr><tr><td>Pyrene</td><td>26-127</td><td>31</td><td>35-142</td><td>36</td></tr></table>	Acceptance Criteria:	Water		Soil			% R	RPD	% R	RPD	Phenol	12-110	42	26-90	35	2-Chlorophenol	27-123	40	25-102	50	1,4-DCB	36-97	28	28-104	27	N-Nitroso-di-n propylamine	41-116	38	41-126	38	1,2,4-Trichlorobenzene	39-98	28	38-107	23	4-Chloro-3-methylphenol	23-97	42	26-103	33	Acenaphthene	46-118	31	31-137	19	4-Nitrophenol	10-80	50	11-114	50	2,4-Dinitrotoluene	24-96	38	28-89	47	Pentachlorophenol	9-103	50	17-109	47	Pyrene	26-127	31	35-142	36	Re-extract and re-analyze MS/MSD
Acceptance Criteria:	Water		Soil																																																																	
	% R	RPD	% R	RPD																																																																
Phenol	12-110	42	26-90	35																																																																
2-Chlorophenol	27-123	40	25-102	50																																																																
1,4-DCB	36-97	28	28-104	27																																																																
N-Nitroso-di-n propylamine	41-116	38	41-126	38																																																																
1,2,4-Trichlorobenzene	39-98	28	38-107	23																																																																
4-Chloro-3-methylphenol	23-97	42	26-103	33																																																																
Acenaphthene	46-118	31	31-137	19																																																																
4-Nitrophenol	10-80	50	11-114	50																																																																
2,4-Dinitrotoluene	24-96	38	28-89	47																																																																
Pentachlorophenol	9-103	50	17-109	47																																																																
Pyrene	26-127	31	35-142	36																																																																
Laboratory Control Sample (Blank Spike)	Each batch (< = 20)	20-120% - See MS/MSD for details	Re-extract and re-analyze LCS and associated samples.																																																																	
Surrogate Recovery	Each sample	<table><tr><td>Recovery (%)</td><td colspan="2">Soil</td><td colspan="2">Water</td></tr><tr><td>Nitrobenzene</td><td>23-120</td><td></td><td>35-114</td><td></td></tr><tr><td>2-Fluorobiphenyl</td><td>30-115</td><td></td><td>43-116</td><td></td></tr><tr><td>Terphenyl-d14</td><td>18-137</td><td></td><td>33-141</td><td></td></tr><tr><td>Phenol-d5</td><td>24-113</td><td></td><td>10-110</td><td></td></tr><tr><td>2-Fluorophenol</td><td>25-121</td><td></td><td>21-110</td><td></td></tr><tr><td>2,4,6-Tribromophenol</td><td>19-122</td><td></td><td>10-123</td><td></td></tr></table>	Recovery (%)	Soil		Water		Nitrobenzene	23-120		35-114		2-Fluorobiphenyl	30-115		43-116		Terphenyl-d14	18-137		33-141		Phenol-d5	24-113		10-110		2-Fluorophenol	25-121		21-110		2,4,6-Tribromophenol	19-122		10-123		If 2 Acid or 2 B/N, or 1 Acid and 1 B/N are out, extract and re-analyze. If still outside, matrix interference is suspected																														
Recovery (%)	Soil		Water																																																																	
Nitrobenzene	23-120		35-114																																																																	
2-Fluorobiphenyl	30-115		43-116																																																																	
Terphenyl-d14	18-137		33-141																																																																	
Phenol-d5	24-113		10-110																																																																	
2-Fluorophenol	25-121		21-110																																																																	
2,4,6-Tribromophenol	19-122		10-123																																																																	
Calibration Check Standard (Reference Material)	Monthly or whenever new standards are prepared	All D% should be < / = 10% D, except chloroaniline, nitroanilines, nitrophenols, nitrosophenylamine, and 2,2'-oxybis (1-chloropropane) with D% < = 30	Repeat the calibration; if still fail, make up new standard and re-analyze until pass																																																																	

Table 7-4 QC Level of Effort and Corrective Action for EPA Method 8080 (PCBs)

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action															
3 pt. Initial Calibration (PCB-1254) and one point for multicomponent <sup>3</sup>	As needed	RSD < 20%	Re-calibrate before sample analysis															
Continuing calibration <sup>1</sup>	Every 12 hours	%D < 15%	Re-calibrate and re-analyze last sample group affected															
Instrumentation Blank	Every 12 hours	All target compounds should be below MDL	Clean the system before analysis															
Method Blank	Each batch	All target compounds should be below MDL	Re-extract and re-analyze the blank and associated samples															
Matrix Spike/Matrix Spike Duplicate	Each batch (< = 20)	Acceptance Criteria: <table><thead><tr><th></th><th colspan="2">Soil</th><th colspan="2">Water</th></tr><tr><th></th><th>% R</th><th>RPD</th><th>% R</th><th>RPD</th></tr></thead><tbody><tr><td>PCB -1254</td><td>65-135</td><td>35</td><td>65-135</td><td>20</td></tr></tbody></table>		Soil		Water			% R	RPD	% R	RPD	PCB -1254	65-135	35	65-135	20	Re-extract and re-analyze MS/MSD
	Soil		Water															
	% R	RPD	% R	RPD														
PCB -1254	65-135	35	65-135	20														
Laboratory Control Sample (Blank Spike)	Each batch (< = 20)	65-135%	Re-extract and re-analyze LCS and associated samples															
Surrogate Recovery <sup>2</sup>	Each sample	<table><thead><tr><th></th><th>Soil</th><th>Water</th></tr></thead><tbody><tr><td>TCX</td><td>65-135</td><td>65-135</td></tr><tr><td>DCB</td><td>65-135</td><td>65-135</td></tr></tbody></table>		Soil	Water	TCX	65-135	65-135	DCB	65-135	65-135	Re-extract and re-analyze samples if both surrogates fail						
	Soil	Water																
TCX	65-135	65-135																
DCB	65-135	65-135																

<sup>1</sup> Continuing calibration and PCB -1254 breakdown check (performance evaluation sample) need to be analyzed ever 12 hours alternatively.

<sup>2</sup> The surrogate recoveries for sample are advisable.

<sup>3</sup> 3-pt calibration required every 6 months for multicomponents.

Table 7-5 QC Level of Effort and Corrective Action for EPA Method 8015 Modified

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action												
5 pt. Calibration	Initially/as needed	RSD < 20% or R > .995	Re-calibrate before sample analysis												
Check Standard	Once per five point calibration	%D < 15%	Re-analyze the calibration check standard or prepare fresh primary standard												
Continuing Calibration	Every 10 samples	%D < 15%	Recalibrate and re-analyze last sample group affected												
Method Blank	Each batch	No interference above the reported detection limit for target compounds.	Re-extract and re-analyze the blank and associated samples												
Matrix Spike/Matrix Spike Duplicate	Each batch (< = 20)	<table border="1"> <thead> <tr> <th colspan="2">SOIL</th> <th colspan="2">WATER</th> </tr> <tr> <th>%R</th> <th>RSD</th> <th>%R</th> <th>RSD</th> </tr> </thead> <tbody> <tr> <td>64-140</td> <td>35</td> <td>70-130</td> <td>25</td> </tr> </tbody> </table>	SOIL		WATER		%R	RSD	%R	RSD	64-140	35	70-130	25	Re-extract and re-analyze MS/MSD
SOIL		WATER													
%R	RSD	%R	RSD												
64-140	35	70-130	25												
Laboratory Control Sample (Blank Spike)	Each batch (< = 20)	70-130%	Re-extract and re-analyze LCS and associated samples												
Surrogate Recovery	Each sample	Bromofluorobenzene: 60-140(S), 65-135(W) Hexacosane: 55-150(S), 60-140(W)	If both are out, re-extract and re-analyze. If still out matrix interference is suspected												

Table 7-6 QC Level of Effort and Corrective Action for EPA Method 6010

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Blank and 2 pt. Initial Calibration	Initially/as needed Must be done once every 24 hours	One standard at 5X MDL	
ICV	After initial calibration at the highest IC concentration	95-105% recovery	Correct problem, recalibrate and re-analyze affected samples.
ICB	Immediately after ICV	Target analytes < MDL	Correct problem, recalibrate and re-analyze affected samples.
CCV	Every 10 samples and at the end of the run.	90-110% recovery of true value.	Correct problem, recalibrate and re-analyze affected samples.
CCB	Every 10 samples following CCV	Target analytes < MDL	Correct problem, recalibrate and re-analyze affected samples.
Method Blank	Each batch (< = 20)	No interference above the method detection limit for target analytes	Re-digest and re-analyze LCS and associated samples
Matrix Spike	Each batch (< = 20)	75-125% recovery, RPD < 35%	No action based on MS alone
Laboratory Control Sample	Each batch (< = 20)	75-125% recovery	Re-digest and re-analyze LCS and associated samples.
Serial Dilution	For high conc. sample, if necessary.	1:5 dilution, RPD 20%	No action, chemical or physical interference effect is suspected.
Duplicate	Each batch (< = 20)	RPD = 35%	No action
Duplicate injection	Each sample	RSD = 30%	Re-analysis

Table 7-7 QC Level of Effort and Corrective Action for EPA Method 7000 Series

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
5 pt. Initial Calibration	Initially/as needed Must be done once every 24 hours		
CCV	Every 10 samples	90-110% Recovery of true value	Correct problem, recalibrate, and re-analyze affected samples
CCB	Every 10 samples, following CCV	Target analytes < MDL	Correct problem, recalibrate, and re-analyze affected samples.
Method Blank	Each batch (< = 20)	No interference above the reported detection limit for target analytes.	Re-digest and re-analyze any samples affected
Matrix Spike	Each batch (< = 20)	75-125% recovery, RPD < 35%	Re-digest and re-analyze duplicate pair
Duplicate	Each batch (< = 20)	RPD = 35%	Re-digest and re-analyze duplicate pair
Blank Spike/LCS	Every 20 samples	80-120% recovery	Re-digest and re-analyze including associated samples

Table 7-8 QC Level of Effort and Corrective Action for EPA Method 7471

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
5 pt. Initial Calibration	Initially/as needed Must be done once per 24 hours	Correlation coefficient $> 0.995$	Re-calibrate before sample analysis
ICV	Follows 5-pt initial calibration	90-110% Recovery	Re-calibrate before sample analysis.
ICB	Follows ICB	No interference $> MDL$	Correct problem, re-calibrate and re-analyze affected samples.
CCV	Every 15 samples	90-110% recovery of true value	Correct problem, re-calibrate, and re-analyze affected samples
CCB	Follows CCV	No interference $> MDL$	Correct problem, re-analyze affected samples to the last good CCB
Method Blank	Each batch ( $< = 20$ )	No interference above MDL	Re-digest and re-analyze any samples affected
Matrix Spike	Each batch ( $< = 20$ )	75-125% recovery	Re-digest and re-analyze MS
Duplicate	Each batch ( $< = 20$ )	RPD = 25%	Re-digest and re-analyze duplicate pair
Laboratory Control Sample (Solid)	Each batch ( $< = 20$ )	80-120% recovery of true value	Re-digest and re-analyze LCS and associated samples
Blank Spike (Aqueous)	Each batch ( $< = 20$ )	75-125% recovery, RPD = 25%	No action.

Table 7-9 QC Level of Effort and Corrective Action for EPA Method 418.1

QC Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
5 pt. Initial Calibration	Initially/as needed	RSD < = 30%	Re-run before sample analysis
Continuing calibration	12 hours	%D < 25%	Recalibrate and re-analyze last sample group affected.
Matrix Spike/Matrix Spike Duplicate	Each batch (< = 20)	70-130% (W) 65-135% (S)	No action is taken based on MS/MSD alone
Laboratory Control Sample (Blank Spike)	Each batch (< = 20)	75-125%	Re-extract and re-analyze LCS and associated samples.
Method Blank	Each day, before any samples	No interference above the reported detection limit for target compounds	Re-extract and re-analyze
Instrument Blank	Daily	No interference above the reported detection limit for target compounds	Clean the system, re-analyzed

Standard solutions are validated prior to use. Validation procedures can range from a check for chromatographic purity, to verification of the concentration of the standard using a standard prepared at a different time or obtained from a different source. Stock and working standards are checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care is exercised in the proper storage and handling of standard solutions, and all containers are labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation). Reagents are examined for purity by subjecting an aliquot or subsample to the corresponding analytical method, as well.

A database is used to store essential information on specific standards or reagents. The system is designed to serve various functions (e.g., the system issues warnings on expiration dates and allows chemists to obtain a list of all working standard solutions prepared from the same stock solution). The program also facilitates the management and audit of reagents and standards.

### **7.2.2 Gas Chromatography (GC)**

The field of GC involves a variety of instrumentation and detection systems. While calibration standards and acceptance criteria vary depending on the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply uniformly. Each GC system is calibrated prior to the performance of analyses. Initial calibration consists of determining the linear range, establishing limits of detection, establishing relative response factors, establishing calibration curves, and establishing retention time windows. The calibration is checked on the established frequency basis to ensure that the system remains within specifications. The established criteria for initial and ongoing calibration of GC methods are 20 percent relative standard deviation (RSD) and  $\pm 15$  percent, respectively.

### **7.2.3 Gas Chromatography/Mass Spectroscopy (GC/MS)**

GC/MS is used to analyze volatiles and semi-volatiles in samples. In EPA Method 8240, the GC/MS is checked for tuning at 12-hour intervals with 50 ng 4-bromofluorobenzene (BFB). All mass ions and their relative ratio must be within QC limits before analyses begin. If the tuning criteria are not met, the system will be tuned manually and BFB will be reinjected. The use of background subtractions or undocumented techniques which result in distorted or skewed spectra is unacceptable in meeting tune criteria.



When the tuning criteria are met, an instrument blank with organic free water, spiked with 50 parts per billion (ppb) of internal standard (IS) and surrogate is analyzed to ensure the system is free of contamination before any analyses begin. Daily method blanks will be kept in the QC file. A five-point calibration curve at 10, 20, 50, 100 and 200 ug/L are analyzed. The relative response factor (RRF) of system performance check compounds (SPCC) and RSD of calibration check compounds (CCC) for each analyte of interest will be checked.

If all QC parameters meet the QC limit, sample analyses can begin. If any one of the QC criteria are not met, corrective action will be initiated. In every 12-hour interval, a BFB tuning check must be performed with 50 ppb of each CCC.

In EPA Method 8270, the GC/MS is checked for tuning at 12-hour intervals with 50 ng Decalfluorotriphenylphosphine (DFTPP) and for inertness of injection port with DDT, benzidine, and pentachlorophenol (PCP). Degradation of DDT should not exceed 20%, and the tailing factor for benzidine and PCP should be  $\pm 3$ . All mass ions and their relative ratio must be within QC limit before analyses begin. If the tuning criteria are not met, try to tune the system manually and DFTPP is reinjected.

When the tuning and injection port inertness criteria are met, an instrument blank with methylene chloride, spiked with 40 ppm of IS and surrogate is analyzed to ensure the system is free of contamination before any analyses begin. Daily instrument blanks will be kept in the QC file. A five-point calibration curve at 10, 25, 40, 50, 60 and 80 mg/L will be prepared. The RRF of SPCC and RPD of CCC for each analyte of interest will be checked for compliance with the contract. If all QC parameters meet the QC limit, sample analyses can begin. If any one of the QC criteria is not met, corrective action will be initiated. In every 12-hour interval, a DFTPP tuning check must be performed before a 50 ppm of continuing calibration check.

#### **7.2.4 Graphite Furnace Atomic Absorption, Cold Vapor Atomic Absorption, and Inductively Coupled Argon Plasma**

Calibration standards will be prepared by diluting stock metal solutions at the time of analysis. Low calibration standards will be prepared fresh each time analysis is to be conducted, and discarded after use. A calibration blank and at least three calibration standards within the linear working range of the instrument will be prepared. The requirement for an acceptable graphite furnace atomic absorption (GFAA) or cold vapor atomic absorption (CVAA) initial calibration is a correlation coefficient equal to or greater than 0.995. The calibration blank will be prepared from the same type of acid used to prepare the samples. The calibration blank will be injected first, followed by the standards, in order from the lowest to the highest concentration, and the absorbance response will be recorded. For GFAA and inductively coupled argon plasma (ICAP), all continuing calibration concentrations must agree with the initial calibration to within 10 percent. For CVAA, all continuing calibration results must agree with the initial calibration

to within 20 percent. Initial calibration will be verified every 10 samples and at the end of each analytical run, using a calibration blank and a single point check standard. If the CCV is outside the specified control limits, the continuing calibration standard will be reanalyzed and any affected samples (i.e., the preceding 10 samples, all analytical sample analyzed since the last compliant CCV) will be reanalyzed.

The CCV standard will be analyzed for each element after the tenth sample, or every 2 hours, whichever is more frequent. The CCV standard also will be analyzed before the first sample and after the last sample in the analytical sequence. QC check standards will be used to verify the initial calibration for the instrument, and these solutions will have a dissimilar origin from the calibration's standards. All continuing calibration results must agree with the initial calibration to within the required specification for each type of instrumentation and each analysis type. If the verification fails to meet the required specification, the analyses will be terminated, the problem corrected, the instrument recalibrated, and the previous 10 samples reanalyzed. The GFAA, CVAA, and ICAP will be calibrated daily, and each time the instrument is set up.

#### **7.2.5 Spectrophotometer**

A polystyrene sample will be used to check instrument wavelength. Acceptance criteria will be as per manufacturer's specifications. Spectrophotometers will be calibrated daily before any samples are analyzed. The calibration standards will be prepared from reference materials, at five concentrations to cover the anticipated range of measurements, and will include a calibration blank. The requirement for an acceptable initial calibration is a correlation coefficient equal to or greater than 0.995. Before sample analysis, an initial calibration verification standard will be analyzed. The response of this standard must be within 15 percent of the initial calibration or the instrument will be recalibrated.

#### **7.2.6 Alpha/Beta Gas Flow Proportional Detector**

For beta calibration, a standard solution of cesium 137 or strontium 90 in equilibrium with its daughter yttrium 90 will be used. A standard (known disintegration rate) in an aqueous solution of sample solids similar in composition to that of the present samples will be prepared. Increments of the solution will be dispensed in tared pans and evaporated. A series of samples having a solids thickness of 1 to 10 mg/cm<sup>2</sup> of bottom area in the counting pan will be made. The samples will be evaporated carefully to obtain uniform solids deposition. The samples will then be dried (103 to 105°C), weighed, and counted. The ratio of counts per minute to disintegrations per minute (efficiency) for different weights of sample solids will be calculated. The efficiency will be plotted as a function of sample thickness and the resulting calibration curve will be used to convert counts per minute (cpm) to disintegrations per minute (dpm). The calibration curves are to obtain the counting efficiency. Each of the isotopes used for a calibration curve will give a significantly different efficiency and crosstalk (amplification factor) value. Care will be taken

in deciding which isotope curve to use when counting samples. Separate, plated, traceable standards will be used for daily instrument operation quality control.

For alpha calibration, the procedures described above for beta calibration will be used with a standard solution of natural uranium salt in secular equilibrium (not depleted uranium), thorium 230, plutonium 239, or americium 241. The alpha standard will be recited at the beta operating voltage to determine the alpha amplification factor. The alpha amplification factor is alpha into beta crosstalk when counting alpha and beta simultaneously. Calibration standards used for calibration will be reported with the analysis results.

## **8.0 ANALYTICAL PROCEDURES**

The chemical analysis program proposed for the SI at BANGF is designed to produce NTAM data using EPA methods as described in *Test Methods for Evaluating Solid Wastes (Physical/Chemical Methods)*, SW-846, Third Edition, and other applicable documents. With the exception of the gross alpha/beta activity samples, CKY Analytical Services will perform the chemical analysis of the BANGF SI samples. CKY Analytical Services is located in Torrance, California, and is certified as a Hazardous Waste and Drinking Water Testing Laboratory by the State of California Department of Health Services Environmental Laboratory Accreditation Program (ELAP). Gross alpha/beta activity samples will be analyzed by Radiation Technical Services, Baton Rouge, Louisiana.

### **8.1 SELECTION OF PARAMETERS**

Analytical parameters for the BANGF SI sampling program were selected based on a review of the site's operational history, characterizations, and previous site investigations. Specific parameters that will be analyzed for the SI and their respective MDLs are listed in Table 8-1. Further details concerning the site sampling program are provided in the Sampling and Analysis Plan.

### **8.2 SAMPLE PREPARATION**

All samples being prepared by the laboratory will be entered into a sample preparation logbook for the method. Information provided in this log book are useful in interpreting unusual analytical results. In addition, the logbook provides information which can be used to determine whether or not the samples were prepared within the holding time requirements.

#### **8.2.1 Organic Preparation**

Samples are received by the sample extraction section for extraction prior to analysis by GC or GC/MS. For liquid samples, separatory funnel or continuous liquid-liquid extraction methods are used. For soil samples, sonication or soxhlet methods are the preferred choice. Methylene chloride is the most common solvent. The extract is dried and concentrated, and then goes through a clean-up or analyzed directly by the appropriate method.

#### **8.2.2 Metal Preparation**

Both liquid and solid samples have to go through acid digestion before analysis. To determine metal content in liquid samples, the samples are vigorously digested with nitric acid followed by dilution with either hydrochloric acid (GFAA) or nitric acid (Flame AA or ICPEs). For solid samples, hydrogen peroxide in addition to nitric acid, is used as an oxidizing agent to speed up the metal digestion.

Table 8-1 Analytical Methods and Method Detection Limits

EPA Method No.	Analytical Method	Analyte	Method Detection Limit	
			Water ug/L	Soil ug/kg
8240	Volatiles/Soil & Water/GCMS	Acetone	5	5.0
8240	Volatiles/Soil & Water/GCMS	Benzene	1.	1.0
8240	Volatiles/Soil & Water/GCMS	Bromodichloromethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	Bromoform	1	1.0
8240	Volatiles/Soil & Water/GCMS	Bromomethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	2-Butanone (MEK)	5	1.0
8240	Volatiles/Soil & Water/GCMS	Carbon Disulfide	1	1.0
8240	Volatiles/Soil & Water/GCMS	Carbon Tetrachloride	1	1.0
8240	Volatiles/Soil & Water/GCMS	Chlorobenzene	1	1.0
8240	Volatiles/Soil & Water/GCMS	Chlorodibromomethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	Chloroethane	2	1.0
8240	Volatiles/Soil & Water/GCMS	2-Chloroethyl Vinyl Ether	1	5.0
8240	Volatiles/Soil & Water/GCMS	Chloroform	1	1.0
8240	Volatiles/Soil & Water/GCMS	Chloromethane	2	2.0
8240	Volatiles/Soil & Water/GCMS	Dibromoethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	Dichlorodifluoromethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	1,1-Dichloroethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	1,2-Dichloroethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	1,1-Dichloroethene	1	1.0
8240	Volatiles/Soil & Water/GCMS	trans-1,2-Dichloroethene	1	1.0
8240	Volatiles/Soil & Water/GCMS	cis-1,2-Dichloroethene	1	1.0
8240	Volatiles/Soil & Water/GCMS	1,2-Dichloropropane	1	1.0
8240	Volatiles/Soil & Water/GCMS	cis-1,3-Dichloropropene	1	1.0
8240	Volatiles/Soil & Water/GCMS	trans-1,3-Dichloropropene	1	1.0
8240	Volatiles/Soil & Water/GCMS	Ethylbenzene	1	1.0
8240	Volatiles/Soil & Water/GCMS	2-Hexanone	1	1.0
8240	Volatiles/Soil & Water/GCMS	Methylene Chloride	5	5.0
8240	Volatiles/Soil & Water/GCMS	4-Methyl-2-pentanone (MIBK)	1	1.0
8240	Volatiles/Soil & Water/GCMS	Styrene	1	1.0
8240	Volatiles/Soil & Water/GCMS	1,1,2,2-Tetrachloroethane	1	5.0
8240	Volatiles/Soil & Water/GCMS	Tetrachloroethene	1	1.0
8240	Volatiles/Soil & Water/GCMS	Toluene	1	1.0
8240	Volatiles/Soil & Water/GCMS	1,1,1-Trichloroethane	1	1.0

GFAA - graphite furnace atomic absorption

CVAA - cold vapor atomic absorption

ICP - inductively coupled plasma

GCEC - gas chromatography/electron capture

GCMS - gas chromatography/mass spectrometry

Table 8-1 Analytical Methods and Method Detection Limits (continued)

EPA Method No.	Analytical Method	Analyte	Method Detection Limit	
			Water ug/L	Soil ug/kg
8240	Volatiles/Soil & Water/GCMS	1,1,2-Trichloroethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	Trichloroethene	1	1.0
8240	Volatiles/Soil & Water/GCMS	Trichlorofluoromethane	1	1.0
8240	Volatiles/Soil & Water/GCMS	Vinyl Acetate	1	5.0
8240	Volatiles/Soil & Water/GCMS	Vinyl Chloride	1	2.0
8240	Volatiles/Soil & Water/GCMS	Xylenes	1	1.0
8270	Semivolatiles/Water & Soil/GCMS	N-Nitrosodimethylamine	10	330
8270	Semivolatiles/Water & Soil/GCMS	Phenol	10	330
8270	Semivolatiles/Water & Soil/GCMS	Pyridine	10	330
8270	Semivolatiles/Water & Soil/GCMS	Aniline	10	330
8270	Semivolatiles/Water & Soil/GCMS	bis (2-chloroethyl) ether	10	330
8270	Semivolatiles/Water & Soil/GCMS	2-Chlorophenol	10	330
8270	Semivolatiles/Water & Soil/GCMS	1, 3-Dichlorobenzene	10	330
8270	Semivolatiles/Water & Soil/GCMS	1, 4-Dichlorobenzene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Benzyl Alcohol	10	330
8270	Semivolatiles/Water & Soil/GCMS	1,2-Dichlorobenzene	10	330
8270	Semivolatiles/Water & Soil/GCMS	2-Methylphenol	10	330
8270	Semivolatiles/Water & Soil/GCMS	2,2'-oxybis(1-Chloropropane)	10	330
8270	Semivolatiles/Water & Soil/GCMS	4 Methylphenol	10	330
8270	Semivolatiles/Water & Soil/GCMS	N-Nitroso-di-n-propylamine	10	330
8270	Semivolatiles/Water & Soil/GCMS	Hexachloroethane	10	330
8270	Semivolatiles/Water & Soil/GCMS	Nitrobenzene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Isophorene	10	330
8270	Semivolatiles/Water & Soil/GCMS	2-Nitrophenol	10	330
8270	Semivolatiles/Water & Soil/GCMS	2,4-Dimethylphenol	10	330
8270	Semivolatiles/Water & Soil/GCMS	Benzoic Acid	25	800
8270	Semivolatiles/Water & Soil/GCMS	bls (2-Chloroethoxy) methan	10	330
8270	Semivolatiles/Water & Soil/GCMS	2,4-Dichlorophenol	10	330
8270	Semivolatiles/Water & Soil/GCMS	1,2,4-Trichlorobenzene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Naphthalene	10	330
8270	Semivolatiles/Water & Soil/GCMS	4 Chloroaniline	20	330
8270	Semivolatiles/Water & Soil/GCMS	Hexachloro-1,3-butadiene	10	330
8270	Semivolatiles/Water & Soil/GCMS	4-Chloro-3-methylphenol	20	330
8270	Semivolatiles/Water & Soil/GCMS	2-Methylnaphthalene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Hexachlorocyclopentadiene	10	330
8270	Semivolatiles/Water & Soil/GCMS	2,4,6-Trichlorophenol	10	330

GFAA - graphite furnace atomic absorption

CVAA - cold vapor atomic absorption

ICP - inductively coupled plasma

GCEC - gas chromatography/electron capture

GCMS - gas chromatography/mass spectrometry

Table 8-1 Analytical Methods and Method Detection Limits (continued)

EPA Method No.	Analytical Method	Analyte	Method Detection Limit	
			Water ug/L	Soil ug/kg
8270	Semivolatiles/Water & Soil/GCMS	2,4,5-Trichlorophenol	25	800
8270	Semivolatiles/Water & Soil/GCMS	2-Chloronaphthalene	10	330
8270	Semivolatiles/Water & Soil/GCMS	1-Chloronaphthalene	10	330
8270	Semivolatiles/Water & Soil/GCMS	2-Nitroaniline	25	800
8270	Semivolatiles/Water & Soil/GCMS	Dimethylphthalate	10	330
8270	Semivolatiles/Water & Soil/GCMS	Acenaphthylene	10	330
8270	Semivolatiles/Water & Soil/GCMS	2,6-Dinitrotoluene	10	330
8270	Semivolatiles/Water & Soil/GCMS	3-Nitroaniline	25	800
8270	Semivolatiles/Water & Soil/GCMS	Acenaphthene	10	330
8270	Semivolatiles/Water & Soil/GCMS	2,4-Dinitrophenol	25	800
8270	Semivolatiles/Water & Soil/GCMS	4-Nitrophenol	25	800
8270	Semivolatiles/Water & Soil/GCMS	Dibenzofuran	10	330
8270	Semivolatiles/Water & Soil/GCMS	2,4-Dinitrotoluene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Diethylphthalate	10	330
8270	Semivolatiles/Water & Soil/GCMS	4-Chlorophenyl-phenylether	10	330
8270	Semivolatiles/Water & Soil/GCMS	Fluorene	10	330
8270	Semivolatiles/Water & Soil/GCMS	4-Nitroaniline	25	800
8270	Semivolatiles/Water & Soil/GCMS	4,6-Dinitro-2-methylphenol	25	800
8270	Semivolatiles/Water & Soil/GCMS	N-Nitrosodiphenylamine 1	10	330
8270	Semivolatiles/Water & Soil/GCMS	4-Bromophenyl-phenylether	10	330
8270	Semivolatiles/Water & Soil/GCMS	Hexachlorobenzene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Pentachlorophenol	25	800
8270	Semivolatiles/Water & Soil/GCMS	Benzidine	25	800
8270	Semivolatiles/Water & Soil/GCMS	Phenanthrene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Anthracene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Di-n-butylphthalate	10	330
8270	Semivolatiles/Water & Soil/GCMS	Fluoranthene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Pyrene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Butylbenzylphthalate	10	330
8270	Semivolatiles/Water & Soil/GCMS	3,3-Dichlorobenzidine	10	330
8270	Semivolatiles/Water & Soil/GCMS	Benzo (a) anthracene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Chrysene	10	330
8270	Semivolatiles/Water & Soil/GCMS	bis (2-Ethylhexyl) phthalate	10	330
8270	Semivolatiles/Water & Soil/GCMS	Di-n-octylphthalate	10	330
8270	Semivolatiles/Water & Soil/GCMS	Benz (b) fluoranthene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Benzo (k) fluoranthene	10	330

GFAA - graphite furnace atomic absorption

CVAA - cold vapor atomic absorption

ICP - inductively coupled plasma

GCEC - gas chromatography/electron capture

GCMS - gas chromatography/mass spectrometry



Table 8-1 Analytical Methods and Method Detection Limits (continued)

EPA Method No.	Analytical Method	Analyte	Method Detection Limit	
			Water ug/L	Soil ug/kg
8270	Semivolatiles/Water & Soil/GCMS	Benzo (a) pyrene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Indeno (1,2,3-cd) pyrene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Dibenzo (a,h) anthracene	10	330
8270	Semivolatiles/Water & Soil/GCMS	Benzo (g,h,i) perylene	10	330
8270	Semivolatiles/Water & Soil/GCMS	1-Chloronaphthalene	10	330
8270	Semivolatiles/Water & Soil/GCMS	1,2-Diphenylhydrazine	25	800
8080	PCB/Soil/GCEC	Aroclor 1016	-----	100
8080	PCB/Soil/GCEC	Aroclor 1221	-----	100
8080	PCB/Soil/GCEC	Aroclor 1232	-----	100
8080	PCB/Soil/GCEC	Aroclor 1242	-----	100
8080	PCB/Soil/GCEC	Aroclor 1248	-----	100
8080	PCB/Soil/GCEC	Aroclor 1254	-----	100
8080	PCB/Soil/GCEC	Aroclor 1260	-----	100
EPA Method No.	Analytical Method	Analyte	Method Detection Limit	
			Water mg/L	Soil mg/kg
418.1	TPH/Water & Soil/IR	Total Petroleum Hydrocarbo	10	1
EPA Method No.	Analytical Method	Analyte	Method Detection Limit	
			Water ug/L	Soil mg/kg
200.7 & 3050/6010	Metals/Water & Soil/ICP	Aluminum	100	5.0
200.7 & 3050/6010	Metals/Water & Soil/ICP	Antimony	100	5.0
200.7 & 3050/6010	Metals/Water & Soil/ICP	Barium	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Beryllium	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Cadmium	5	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Calcium	100	5.0
200.7 & 3050/6010	Metals/Water & Soil/ICP	Chromium	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Cobalt	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Copper	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Iron	50	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Magnesium	100	5.0
200.7 & 3050/6010	Metals/Water & Soil/ICP	Manganese	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Molybdenum	50	0.5

GFAA - graphite furnace atomic absorption

CVAA - cold vapor atomic absorption

ICP - inductively coupled plasma

GCEC - gas chromatography/electron capture

GCMS - gas chromatography/mass spectrometry



Table 8-1 Analytical Methods and Method Detection Limits (continued)

EPA Method No.	Analytical Method	Analyte	Method Detection Limit	
			Water ug/L	Soil mg/kg
200.7 & 3050/6010	Metals/Water & Soil/ICP	Nickel	20	1.0
200.7 & 3050/6010	Metals/Water & Soil/ICP	Potassium	2,000	100
200.7 & 3050/6010	Metals/Water & Soil/ICP	Silver	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Sodium	100	5.0
200.7 & 3050/6010	Metals/Water & Soil/ICP	Thallium	200	10
200.7 & 3050/6010	Metals/Water & Soil/ICP	Vandium	10	0.5
200.7 & 3050/6010	Metals/Water & Soil/ICP	Zinc	10	0.5
245.1/7471	Metals/Water & Soil/CVAA	Mercury	0.2	0.05
206.2/3050 & 7060	Metals/Water & Soil/GFAA	Arsenic	10	10
270.2/3050 & 7740	Metals/Water & Soil/GFAA	Selenium	5	5.0
239.2/3050 & 6010	Metals/Water & Soil/GFAA	Lead	20	5.0
9310	Gross Alpha/Water/ Proportional Detector	Gross Alpha	0.10 pCi/L	-----
9310	Gross Beta/Water/ Proportional Detector	Gross Beta	0.10 pCi/L	-----

GFAA - graphite furnace atomic absorption

CVAA - cold vapor atomic absorption

ICP - inductively coupled plasma

GCEC - gas chromatography/electron capture

GCMS - gas chromatography/mass spectrometry

### 8.3 REFERENCE MATERIALS

Standard solutions needed to generate method performance data, calibrate instruments, spike analytical surrogates or internal standards, prepare QC samples, or prepare performance samples will be obtained from the NIST, or will be traceable to the NIST. If the required reference materials are not available from the NIST, CKY will obtain the reference materials from the EPA or other reliable commercial sources. Reference materials obtained from the EPA will not require characterization prior to use. However, "off the shelf" reference materials from other commercial sources will be characterized prior to use to obtain a positive estimate of purity.

Reference materials for metals and non-metallic inorganics may be maintained at room temperature in a locked storage area. All other reference materials must be stored in a locked refrigerator at or below 4°C. All reference materials will be maintained under chain-of-custody.

### 8.4 ANALYTICAL METHODS

The following sections describe the analytical methods that will be used for the parameters selected for the BANGF SI..

#### 8.4.1 GC/MS Volatiles

Proposed Water and Soil Method and Reference: The proposed method of analysis for water and soil is EPA Method 8240 (SW-846).

Water Method Summary: A 5-ml portion of the sample is spiked with internal standard and surrogate then transferred to the purge and trap apparatus. The sample is purged with helium and the analytes are trapped on a 3-phase sorbent tube. The analytes are desorbed at 180°C into a Finnigan 5100 gas chromatograph/mass spectrometer with electron impact ionization and quadrapole detector.

Soil Method Summary: A 5-gram portion of the sample is weighed directly into the sparging vessel. 5 ml of reagent water with internal standards and surrogate (50µg/L) are introduced into the vessel. For mid to high concentrations, 4 grams of soil, 9 ml of methanol, and 1 ml of surrogate are used. An aliquot of methanol extract (up to 100µl) is injected into 5 ml of clean water containing internal standards. The sample is purged with helium, and the analytes are trapped on a 3-phase sorbent tube. The analytes are desorbed at 180°C into a Finnigan gas chromatograph/mass spectrometer with an electron impact ionization source and a quadrapole detector.

#### **8.4.2 GC/MS Semivolatiles (Base Neutral Acids)**

Proposed Water Method and Reference The proposed method of analysis for water is EPA Method 8270 (SW-846).

Water Method Summary: An aliquot (up to 1,000 ml) portion of sample is spiked with surrogate compounds, and extracted with methylene chloride. The extract is dried with sodium sulfate and concentrated to 1 ml with a Kuderna-Danish apparatus. After the sample extract is screened by GC/FID it is injected into a gas chromatograph equipped with a mass spectrometer detector.

Proposed Soil Method and Reference The proposed methods of analysis for soil are EPA Methods 3540 and 8270 (SW-846).

Soil Method Summary: 30g of sample are mixed with 30g of sodium sulfate in a breaker. The breaker is spiked with surrogate spiking solution and extracted with methylene chloride in a soxhlet apparatus. The solvent is concentrated to 10 ml with a Kuderna-Danish apparatus. For medium VOC contamination, use 2g of soil and concentrate solvent to 1 ml. The sample extract is screened by GC/FID and injected into a gas chromatograph equipped with a mass spectrometer detector.

#### **8.4.3 ICP Metals**

Proposed Water Method and Reference: The proposed methods of analysis for water are EPA Method 6010 (SW-846) and EPA Method 200.7 (600/4-79-020, March 1983).

Water Method Summary: A 50-ml portion of the sample is heated in the presence of nitric and hydrochloric acids. The volume is reduced to between 10 and 20 ml. The sample is cooled and diluted to 50 ml with ASTM Type I water. The resulting digest is analyzed using a Thermo Jarrell Ash ICAP 61 equipped with an IBM personal computer - AT and Thermospec software.

Proposed Soil Method and Reference: The proposed methods of analysis for soil are EPA Methods 3050 and 6010 (SW-846).

Soil Method Summary: A 1-gram portion of the sample is heated in the presence of nitric acid and hydrogen peroxide. The sample is evaporated to near-dryness on a hot plate and refluxed with hydrochloric acid. The digest is analyzed using a sequential ICP. The ICP is integrated with a data system capable of controlling the instrument data acquisition function and processing the data acquired, including correcting for interelement interferences.

#### **8.4.4 Graphite Furnace Atomic Absorption (GFAA)**

##### **8.4.4.1 Arsenic**

Proposed Water Method and Reference: The proposed method of analysis for water is EPA Method 206.2.

Water Method Summary: A 100-ml portion of the sample is heated in the presence of nitric acid. The solution is diluted to 100 ml with ASTM type I water. A portion of the resulting digest is mixed with a modifier solution (containing nickel nitrate) and analyzed using a Perkin-Elmer atomic absorption spectrophotometer equipped with a graphite furnace.

Proposed Soil Method and Reference: The proposed method of analysis for soil is certified method B9, which is based on EPA Methods 3050 and 7060 (SW846).

Soil Method Summary: A 1-gram portion of the sample is digested with nitric acid and hydrogen peroxide. The solution is diluted to 100 ml with ASTM type I water. A portion of the resulting digest is mixed with a modifier solution (containing nickel nitrate) and analyzed using a Perkin-Elmer atomic absorption spectrophotometer equipped with a graphite furnace.

##### **8.4.4.2 Lead**

Proposed Water Method and Reference: The proposed method of analysis for water is EPA Method 239.2.

Water Method Summary: A 100 ml portion of the sample is heated in the presence of nitric acid. The solution is filtered and diluted to 100 ml with ASTM type I water. A portion of the resulting digest is mixed with a modifier solution (containing magnesium nitrate and ammonium phosphate) and then analyzed using a Perkin-Elmer atomic absorption spectrophotometer equipped with a graphite furnace.

##### **8.4.4.3 Selenium**

Proposed Water Method and Reference: The proposed method of analysis for water is EPA Method 270.2.

Water Method Summary: A 100-ml portion of sample is heated in the presence of nitric acid. The solution is diluted to 100 ml with ASTM type I water. A portion of the resulting digest is mixed with a modifier solution (Magnesium nitrate and nickel nitrate) and analyzed using a Perkin-Elmer atomic absorption spectrophotometer equipped with a graphite furnace.

Proposed Soil Method and Reference: The proposed methods of analysis for soil are EPA Methods 3050 and 7740 (SW-846).

Soil Method Summary: A 1-gram portion of sample is heated in the presence of nitric acid and hydrogen peroxide. The solution is diluted to 100 ml with ASTM type I water. A portion of the resulting digest is mixed with a modifier solution (Magnesium nitrate and nickel nitrate) and analyzed using a Perkin-Elmer atomic absorption spectrophotometer equipped with a Zeeman Furnace.

#### **8.4.5 Cold Vapor Atomic Absorption (CVAA) - Mercury**

Proposed Water Method and Reference: The proposed method of analysis for water is EPA Method 245.1

Water Method Summary: A 100-ml portion of sample is digested with a sulfuric/nitric acid-potassium permanganate solution by heating for 2 hours at 95°C. After reduction with hydroxylamine hydrochloride, stannous chloride is introduced into the vessel containing the digest and the vessel is attached to a Perkin-Elmer atomic absorption spectrophotometer fitted for determination of mercury by cold vapor.

Proposed Soil Method and Reference: The proposed method of analysis for soil is EPA Method 7471 (SW-846).

Soil Method Summary: A 1-gram portion of sample is digested with aqua regia/potassium permanganate by heating at 95°C. After reduction with hydroxylamine hydrochloride, stannous chloride is introduced into the vessel containing the digest and the vessel is attached to a Perkin-Elmer atomic absorption spectrophotometer fitted for determination of mercury by cold vapor.

#### **8.4.6 Polychlorinated Biphenyls (PCBs)**

Proposed Soil Method and Reference: The proposed method of analysis for soil EPA Method 8080.

Soil Method Summary: A 20-gram sample is extracted with 20 ml acetone/hexane, using a wrist-action shaker. The extract is analyzed by GC/ECD with helium as a carrier gas.

#### **8.4.7 Total Petroleum Hydrocarbons**

Proposed Water Method and Reference: The proposed method of analysis for water is EPA Method 418.1.

Water Method Summary: An 800-ml sample is extracted with 3 X 30 ml of fluorocarbon-113 and brought to a final volume of 100-ml. Following the addition of silica gel, the extract is analyzed by infrared spectrophotometry.

#### **8.4.8 Gross Alpha/Beta Activity**

Proposed Water Method and Reference: The proposed method of analysis for water is EPA Method 9310.

Water Method Summary: An aliquot of a preserved water sample is evaporated to a small volume and transferred quantitatively to a tared 2in stainless steel counting planchet. The sample residue is dried to constant weight, reweighed to determine dry residue weight, and then counted for alpha and/or beta radioactivity.

## **9.0 DATA REDUCTION VALIDATION AND REPORTING**

Data collected during the sampling activities for BANGF will be appropriately identified and validated, and included in the final report for each site. Where test data have been reduced, the method of reduction will be described in the text of such reports. Entry of any data to computer databases will be checked by cross reading hard copy data files with the data in its original form.

### **9.1 FIELD MEASUREMENT DATA**

Validation of data obtained from field measurements will be performed by the task leaders or their designees. Validation of data will be performed by checking procedures utilized in the field and comparing the data to similar, previous measurements when they exist. If there are data which cannot be validated, the reason will be documented.

The following are suggested reporting requirements that may be applied for field data:

- pH: Field measurements will be reported to 0.1 pH units.
- Specific conductance: Field measurement will be reported to +5 percent of the reading, umhos/cm.
- Temperature measurements will be reported to the nearest 0.5°C.
- Water levels: Measurements will be repeated until at least two are documented to be in agreement to the nearest 0.01 foot.
- Aquifer test data: Drawdown and recovery data will be plotted in the field for evaluating aquifer response and will be reported according to the type of analysis performed.
- Soil sample depths: Tape measurements will be made to the nearest 0.1 feet; measurement made by known lengths of drill string will be made to the nearest 0.5 feet.
- Elevations of monitoring wells: Measuring points for all new monitoring wells will be surveyed to the nearest 0.01 foot and referenced to Mean Sea Level. approximate elevations of all other nonsurveyed sampling sites will be determined to the nearest 10 foot
- Locations of sampling sites: Locations of monitoring wells will be surveyed to the nearest 0.01 foot.

Lithologic descriptions: Sample descriptions will be consistent with the Unified Soil Classification System. Grain size will be adequately described for sand and coarse fractions.

## **9.2 LABORATORY DATA**

### **9.2.1 Record Keeping and Review**

Personnel responsible for sample extraction will utilize method-specific bound books to record all data associated with sample extraction and preparation. A copy of the extraction benchsheet will be transferred to the GC analyst with each extracted sample.

The GC laboratories will utilize benchsheets, maintained in analysis-specific binders for QC data; and bound logbooks (instrument-specific) for injection data. Computer generated quantification reports and chromatographs will be filed by accession number.

The individual analysts and technicians will be responsible for maintaining accurate, legible records and logs in accordance with standard operating procedures. The laboratory department supervisors will be responsible for ensuring adherence to procedures.

Raw data and its reduction to final results will be reviewed by the section supervisor or group leader periodically. The frequency and completeness of the review will be individually determined, but is not less than 10 percent of all data every two weeks.

The laboratory QA Manager will be responsible for routinely auditing all records and logs and reporting deficiencies to the laboratory department supervisor for corrective action.

## **9.3 DATA PROCESSING AND COLLECTION**

Data processing includes the collection, validation, storage, transfer, and reduction of analytical data. CKY Analytical Services employs extensive automated data processing procedures, including:

- The generation of standard calibration curves
- Mathematical modeling of standard curves
- Statistical analysis
- Calculations
- Data storage and retrieval
- The generation of hard copy output



### **9.3.1 Validation**

The analytical data generated by the laboratory will be reviewed for PARCC by the QA/QC Officer. The data validation process for this project will consist of data generation, reduction, and review by Laboratory Data Consultants, Inc. of Carlsbad, California. A summary of Laboratory Data Consultants' data validation review process is presented in Appendix A.

#### **9.3.1.1 Analytical Laboratory Data Review**

The first level of review, which may contain multiple sublevels, will be conducted by the analytical laboratory Data Reviewer who has the initial responsibility for the correctness and completeness of the data. All data are generated and reduced in accordance with protocols specified in the analytical methodology. This person will review the data package to ensure that:

- Sample holding times were not exceeded
- Sample preparation information is correct and complete. Analysis information is correct and complete
- The appropriate methods have been followed. Analytical results are correct and complete
- QC samples are within appropriate QC limits
- Special sample preparation and analytical requirements have been met
- Documentation is complete (all anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete, holding times are documented).

The laboratory will perform the in-house analytical data reduction and QA review under the direction of the laboratory Data Review Supervisor. The laboratory Program Administrator is responsible for assessing data quality and advising the Project Manager of any data which were rated "preliminary" or "unacceptable," or other notations which would caution the data user of possible unreliability. Data reduction, QA review, and reporting by the laboratory will be conducted as follows:

- Raw data produced by the analyst is processed and reviewed for attainment of quality control criteria for established EPA methods and for overall reasonableness.
- After entry into the Laboratory Information Management System (LIMS), a computerized report is generated and sent to the laboratory Data Reviewer.
- The Data Reviewer will decide whether any sample reanalysis is required.

- Upon acceptance of the preliminary reports by the Data Reviewer, final reports will be generated.
- Laboratory data reduction procedures will be those specified in EPA SW-846, 3rd Edition.

#### **9.3.1.2 Data Review Process**

Laboratory analytical results will be reviewed by Laboratory Data Consultants, Inc. whose function is to provide an independent review of the data. Laboratory results will be reviewed for acceptance or rejection based on review parameters. The analytical data will undergo evaluation of:

- Holding times
- Blank contamination
- Spike recoveries (MSs, surrogate spikes, and laboratory control sample spikes)
- Duplicate analysis precision (held duplicates, laboratory duplicates, and matrix spike duplicates)
- Usability of data that is estimated due to poor recovery rate of matrix spikes.

#### **9.3.2 Data Storage**

The paperwork containing the raw data for a sample set (i.e., chart paper, computer readouts, paper tapes, calibration curves, tables of data, etc.) is collected and placed in an 8 1/2" by 11" envelope which has been labeled with sample numbers, analyst, date, and other pertinent information. Appropriate and complete data, along with a description of the samples and analytical method, are also entered in the chemist's notebook. The data envelopes are filed by laboratory number for future reference and data retrieval. Each chemist at CKY Analytical Services maintains a bound laboratory notebook in which are detailed events related to sample analyses. Completed notebooks are filed by each chemist. At termination of employment, all laboratory notebooks are placed in archives.

#### **9.3.3 Transfer**

Procedures used ensure that data transfer is error free and that no information is lost in the transfer. Because of the extensive use of a computerized data processing system, data transfer steps are minimized.

#### **9.3.4 Reduction**

To accomplish data reduction, mathematical models based on the analysis of standard solutions or standard samples are generated in order to determine the quantity of analyte present in field samples. Data processing by the computer includes calculations, generation of standard calibration curves, mathematical modeling of standard curves, statistical analyses, and the generation of hard copy output. Four different computerized

mathematical models are available at CKY Analytical Services to fit data derived from the analysis of standards and to generate calibration curves. The analyst has the option of selecting the model which best fits standard data. Once the model has been selected, it will remain constant for all subsequent uses of the method.

The data reduction program allows the analyst to generate a printed plot of the standard curve as an aid in selecting the curve of best fit. Although a correlation coefficient is provided, it is not always the best indication of a reasonable data fit.

## **10.0 INTERNAL QUALITY CONTROL**

### **10.1 QUALITY CONTROL SAMPLING**

QC procedures have been established for both SI Contractor's field and laboratory operations, and the subcontractor drilling activities. Field QC activities include the use of calibration standards and blanks for pH, specific conductance, temperature, and dissolved oxygen measurements. Special samples to be submitted to the laboratory include trip blanks, sampler rinsate blanks, duplicate samples and background samples. These samples provide a quantitative basis for evaluating the data reported. The number and type of field QC samples to be collected is outlined in the Sampling and Analysis Plan.

#### **10.1.1 Trip blanks**

Trip blanks are required for assessing the potential for contaminating samples with VOCs during sampling or in transit. The trip blank consists of a VOC sample container which is shipped to the site with the other VOC sample containers and filled with reagent water. A trip blank is included with each shipment of water samples scheduled for VOC analysis and will be analyzed with the other VOC samples.

#### **10.1.2 Sampler Rinsate Blanks**

A minimum of one sampler blank for the bailer, sampling pump, and/or tubing assembly is scheduled during monitoring well sampling. VOCs, SVOCs, or inorganics present within the bailer, pump apparatus, or discharge tubing are assessed by collecting a sample of rinse water passed through the sampling apparatus after completing the decontamination procedure using the approved water source for decontamination.

A minimum of two soil sampler rinsate blanks are collected during each field event. VOCs, SVOCs, or inorganics present within or on the sampling apparatus where intimate contact with the sample occurs (i.e., split spoon, hand auger, and Shelby tubes) are assessed by pouring organic free water over the sampling apparatus. Rinsates are collected directly into the appropriate container.

#### **10.1.3 Duplicate Samples**

During groundwater sampling, one duplicate groundwater sample will be collected and submitted to the laboratory for every 20 field samples. Given the heterogeneity of soils, and thus the questionable significance of a field soil duplicate, field soil duplicates will not be collected. Duplicate soil samples will be split in the laboratory. Duplicates will be collected at the frequency described in the Sampling and Analysis Plan.

#### **10.1.4 Background Samples**

Background samples will be collected from areas having no known contamination or any likelihood of contamination. Two borings will be drilled at the south end of the BANGF for the collection of background soil samples.

#### **10.2 COMPLETENESS**

Completeness of scheduled sample collection will be controlled in the field by comparing a computer generated label inventory with samples actually collected each day. Daily checking of field data sheets and comparison of transport and COC logs will provide further control of documentation and completeness.

#### **10.3 QUALITY REVIEW AND REPORT PREPARATION**

QC during the preparation of reports relies on documentation of data utilized and peer review of conclusions drawn from the assembled data base. The comparability objective established for the project is of particular importance when data are derived from many sources (i.e., the data base is comprised of secondary measurements). Documentation of secondary data typically is accomplished via data verification/tracking checklists with accompanying written criteria describing "acceptable" data to ensure consistency in data selection. This allows all data base components to be traced to the primary generator and forces a review of data quality as the data base is developed. All project personnel are responsible for utilization and monitoring of this process; compliance is audited by the QAC. Upon completion of the data base, data interpretation, evaluation, and report preparation commence.

To enhance the professional quality of the company's studies and reports, Work Element Leaders will also (1) require that reports refer to and are consistent in scope with the project proposal and contract; and (2) require that report language and contents be chosen to foster client understanding of risks and uncertainties by distinguishing fact from opinion and identifying risks and limitations in a clear and informative manner.

#### **10.4 LABORATORY QUALITY CONTROL CHECKS**

In order to assess the validity of an analytical result, quality control elements are introduced into the entire analytical process. By examining the completeness and quality of all QC parameters, method performance can be assessed and the validity of analytical data can be evaluated. Quality control checks that will be performed by CKY Analytical Services to ensure the validity of all BANGF SI data are described in the following sections.

#### **10.4.1 Calibration**

Calibration defines the quantitative response, linearity and dynamic range of the instrument for each analyte. All analytical instruments shall be calibrated in accordance with requirements which are specific to the instrumentation and procedures employed, as previously discussed in Section 7.2.

#### **10.4.2 System Blanks**

System Blanks contain clean water or solvent that has not gone through the sample work-up. These blanks, however, are analyzed by the instrument. The System Blanks provide information as to possible contamination in the instrument being used. One instrument system blank is analyzed per day.

#### **10.4.3 Laboratory Control Samples**

A LCS is a method blank spiked with a known concentration of analyte or surrogate, processed through the entire preparation and analytical procedures together with the environmental samples. The LCS checks the laboratory performance on the sample preparation and analyses procedures without the matrix interference.

The LCS is prepared for each analytical batch of up to 20 samples. The analytical batch is defined as samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition.

#### **10.4.4 Matrix QC Parameters**

Matrix spike, matrix spike duplicate, field sample duplicate and surrogate recoveries results provide indication of matrix effect in terms of accuracy and precision. These samples are analyzed concurrently with other environmental samples. To prepare a matrix spike sample, a known concentration of analyte/surrogate is added to a sample prior to preparation and extraction. Laboratory duplicate samples are prepared from the same field samples. It is a standard practice throughout the laboratory to prepare and analyze one matrix spike/matrix spike duplicate for each analytical batch of up to 20 samples.

#### **10.4.5 ICP Interference Check Sample**

The ICP checks the ICP interelement and background correction factor to verify the absence of spectral interference. It is analyzed consecutively at the beginning of each eight hour period and at the end of analysis prior to CCV/CCB.

#### **10.4.6 GC/MS Performance Check**

Mass spectrometer performance is monitored every 12 hours of operation by measuring the mass/ion distribution of BFB (volatiles) or DFTPP (semivolatiles). The mass/ion distribution of these compounds has to fulfill the method project specific requirements before analysis can start. Furthermore, mass assignments is checked periodically by using perfluorobutylamine to ensure that mass number is properly assigned.

#### **10.4.7 Sample Container Checks**

Sample containers will be cleaned and documented to be free of any contamination. Background volatiles and metals are analyzed on a per lot basis; results are kept by supervisors for future references.

All organic sample containers must be made of glass with Teflon lined caps or septa. All glassware to be used for organic analysis must be cleaned with soap, rinsed with tap water, rinsed with the laboratory DI water and rinsed with solvent depending on the type of analysis to be performed. Inorganic sample containers must be made of plastic (polyethylene) and washed with soap, water and rinsed with dilute nitric acid.

Section 5.2 provides a discussion of the appropriate sample containers that will be used for the collection of samples for the various parameters of concern.

#### **10.4.8 Thermometer, Balance, and Refrigerator**

Thermometers are calibrated against NBS thermometers on a semi-annual basis. Balances are serviced and certified by service representatives. The accuracy of balances, refrigerators, and oven temperature are monitored daily and permanent records are kept. The tolerance limits are posted with each instrument.

#### **10.4.9 Stationary Blank**

Stationary Blanks are samples containing reagent water that are stored in the sample storage refrigerator. These blanks are analyzed only if contamination was detected in the travel or field blanks. The Stationary Blanks provide information concerning possible contamination in the sample storage refrigerator.

#### **10.4.10 Standard Verification**

Before using a new standard, it must be verified that it is in acceptable condition through analysis. This is accomplished by analyzing the new standard against a standard known to be in acceptable condition. Once the standard is verified acceptable, it may be used for routine analysis.

#### **10.4.11 Reagent Water**

The laboratory makes available clean reagent water for routine lab usage. Reagent water is defined as water in which no interference is observed at the MDL of each parameter of interest. For Organic analysis, tap water is filtered through a charcoaltrap and analyzed for trace levels of interested analytes before use. For inorganic analysis, Type I water is required. Criteria for a type I water are: Minimum electrical resistivity of 16.67 Mr cm; maximum electrical conductivity of 0.06 umho/cm and maximum total matter of 0.1 mg/L. Type I reagent water is generated by the laboratory using a Barnstead's Nanopure system that utilizes a combination of macroreticular resin, carbon, anion-cation resin and membrane filtration. Water is monitored daily by a system built-in conductivity meter and resistivity meter. Out of control events will cause the water source to be removed from use until the problem is corrected.

#### **10.4.12 Reagent Quality Control**

All chemicals used in the laboratory are reagent grade or better. Whenever a new lot of reagent is purchased, it will be subjected to a QC check to ensure that the chemical is free of any contamination that will interfere with analysis. A permanent record is kept for tracking.



## **11.0 AUDITS**

System audits of the field and analytical programs will be performed by the QAC. Field activities will also be audited by the site and project managers. Audits will be performed as early in the field and analytical programs as is reasonably possible to ensure that any developing problems are identified at the earliest time possible. The results of all field and analytical audits will be briefly discussed in the final report for the project. The field audits will focus on adherence to procedures outlined in the QCP and the Sampling and Analysis Plan.

### **11.1 PERFORMANCE AUDITS**

Performance audits will focus on the laboratory analytical program.

A continuous internal performance audit is administered in the laboratory. As discussed earlier, quality control samples are prepared and analyzed routinely within the laboratory as part of the internal quality control program. The data are evaluated by the laboratory QAC as part of the internal quality control program. Any required corrective measures are initiated by the laboratory QAC.

CKY Analytical Services has been previously audited and certified by the U.S. Army Corps of Engineers and the U.S. Navy. In addition, CKY Analytical Services participates in several additional external performance audit programs, including individual state environmental certification programs.

### **11.2 DOCUMENTATION AND REPORTING AUDITS**

#### **11.2.1 Audit Format**

System audits will be formally documented in a comprehensive report. The following information shall be included:

- Document identification;
- Activity audited;
- Name of company and/or individuals(s) performing activity;
- Location;
- Date(s) of audit;
- Name of individual performing audit;
- Reference utilized, e.g., procedures, procurement documents, checklists, etc.;

- Results of audits;
- Summary of observations;
- Listing and/or description of nonconformance(s);
- Listing and/or description of corrective actions taken or to be taken for resolution;
- Listing and/or description of unresolved nonconformance(s); and
- Evaluation statement.

#### **11.2.2 Distribution of Documentation**

Audit reports will be distributed to at least the Program Manager, Task Manager, Laboratory Analytical Coordinator, USAEC, and the record file.

#### **11.2.3 Follow-up Actions**

The individual who performed the audit will be responsible for followup corrective actions to resolve nonconformances which were not serious enough to issue a stop work order. Documentation of this subsequent resolution will be issued to personnel who received the original audit report. The correspondence will specifically reference the actions taken to correct the nonconformances, and contain a current status evaluation and/or statement of acceptance.

#### **11.2.4 Documentation**

The following documents generated by this procedure shall be retained in the QAC's records:

- Schedule of activities;
- Audit schedule and any revisions;
- Documentation of audit responses and corrective action taken;
- Audit reports;
- Follow-up correspondence; and
- All QA documents will be maintained in a permanent fashion.

## **12.0 PREVENTIVE MAINTENANCE**

CKY Analytical Services maintains an instrument maintenance program as part of their overall QA/QC program. The instrument maintenance program consists of three elements: evaluation of instrument performance, good record keeping, and establishing a comprehensive preventive maintenance program.

### **12.1 SYSTEM PERFORMANCE CHECK**

The System Performance Check will be performed on each new instrument after installation and on existing instruments after major modifications have been made. In addition, portions of the System Performance Check may be used as a trouble shooting device whenever analytical problems arise. The purpose of the System Performance Check is to establish the limits of the instrument and method capabilities. This information will set control limits, allowing the analysts to know whether or not the analysis they are performing are within the performance capabilities of the instrument and method.

The System Performance Check includes the following tasks listed below:

- Establish 7-day stability of each instrument for each parameter of interest.
- Establish instrument detection limits for each parameter of interest for each instrument.
- Establish Method Detection Limit (MDL) for each parameter of interest for each instrument.
- Establish the dynamic range (linear range) of each instrument for each parameter of interest.
- Establish method recoveries for each parameter of interest.

### **12.2 INSTRUMENT MAINTENANCE**

Each instrument will be serviced according to the schedules specified by the manufacturer. Preventative maintenance services help reduce instrument downtime and allow instruments to perform at their peak level.

In addition, an inventory of spare parts will be kept for unexpected needs to replace damaged or defective instrument parts. The analyst will perform the necessary routine maintenance required under normal operation of the instrument.

### **12.3 INSTRUMENT RUN LOGBOOK**

The Instrument Run Logbook is an on-going record of all runs performed on the instrument. Each run (data file) appears in the logbook in chronological order indicating the sequence of runs associated with each complete analysis. In addition to providing evidence of whether or not a sample was run on a particular day, the logbook can serve as a diagnostic tool used for additional checks against possible contamination carry-over problems. On occasions, the instrument run log may serve as an official document used in verifying the validity of analysis in a courtroom situation. The Instrument Run Logbook will include the following information:

- Data file name, Lab ID, Sample ID, Client name
- Sample description
- Type of analysis
- Date of preparation and analysis and concentration factor
- Injection volume and instrument condition
- ID code of standard
- ID code for QC
- Name of analyst

### **12.4 INSTRUMENT MAINTENANCE LOGBOOK**

Instrument Maintenance Logbooks contains documentation of all servicing and maintenance performed on the instrument. In addition, any instrument problems including the symptoms are noted in the logbook.

The Instrument Maintenance Logbook will serve as evidence that proper care was taken to keep the instrument at its peak condition. The following information will be included in the Instrument Maintenance Logbook:

- Date and description of instrument problems including the symptoms.
- Date and description of corrective actions taken.
- Date and description of routine maintenance.
- Initial of individual performing the service and entering comments.

- Any recommendations for servicing that will be required in the future.
- Documentation of return to control after repair.

### **13.0 DATA MANAGEMENT**

Data generated from the BANGF SI will be managed in accordance with USAEC data management procedures. Data for this project will include chemical analysis data from the laboratory subcontractor, geotechnical data from the field drilling program, and survey data from the surveyor contractor. The chemical analysis data for BANGF will be entered into the IRDMS by the laboratory and reviewed by the Project Manager. All fieldgenerated data will be transcribed onto field log forms and field daily report forms for transmission of both to the SI Contractor and USAEC. Geotechnical field and survey data will be entered into IRDMS by the SI Contractor.

All laboratory data generated during the BANGF SI will be manually validated by Laboratory Data Consultants, Inc. using the process summarized in Appendix A. Upon completion of the data validation process, the data will be entered into the USAEC database as NTAMS following the procedures outlined in the IRDMIS. Documentation of all data entry will be submitted to the USAEC for review to ensure that all required data qualifiers and flagging codes were included.

## **14.0 CORRECTIVE ACTIONS**

If it appears that field or laboratory data are in error, the error or potential error will be documented and appropriate corrective action will be taken. Corrective actions may include one or more of the following:

- Measurements may be repeated to check the error;
- Calibrations may be checked and/or repeated;
- Instrument or measuring device may be replaced or repaired;
- New samples may be collected; and/or
- Samples may be reanalyzed.

Appropriate corrective actions will be determined on a case by case basis. A discussion of any corrective actions taken will be included in the appropriate final report.

The QAC will be responsible for identification of problems and implementation of corrective actions. If the project manager, task leaders, or project staff become aware of any problems in sample collection or analysis they will immediately notify the QAC who will decide the appropriate action to be taken to correct the problem. Section 11.0 describes the system audits that will be performed by the QAC or designee to monitor sampling and analytical programs. These audits will be performed as early as possible to ensure that developing problems are identified and corrected at the earliest possible time.

### **14.1 LABORATORY CORRECTIVE ACTION**

The laboratory QAC carefully monitors the results of the control samples analyzed and, in the event that a QC result is unacceptable, implements specific steps to identify and correct the deficiency. Generally, a Corrective Action Record is prepared and forwarded to the appropriate Section Manager. Action for correcting the problem, pursued jointly by the analyst, the appropriate Group Leader, the appropriate Section Manager, and the laboratory QAC is recorded on the Corrective Action Record. The steps to be followed include:

- Check all data processing procedures and calculations.
- Check blank samples for identification of possible interferences or other problems.

- Check instrumentation performance (if applicable) by observing the response of the instrument while processing a sample material for which the expected response is known. Operating conditions must be similar to those used for analysis of the samples under consideration.
- Check the original standard preparation procedures by preparing new standards, obtaining a new standard calibration curve from the new data, and comparing the new standard curve with the original standard calibration curve.
- Check the integrity of the original QC samples by preparing new QC samples following the same procedures and analyzing the new QC samples.
- Carefully review raw data (e.g., recorder output, chromatograms, computer output) in an effort to identify interferences, unusual signals (unusual peak shapes, etc.), or other factors which could produce inaccuracies.
- Reanalyze the samples with new standards and new QC samples if sufficient field sample material is available. The entire analytical process including, for example, extractions, digestions, etc. should be repeated if possible.
- If QC results are still unacceptable and no reason has been identified discuss the problem in detail with personnel from the USAEC Geology and Chemistry Branch, Installation Restoration Division and determine how results should be reported.



## **15.0 QUALITY CONTROL REPORTS**

### **15.1 FIELD QUALITY CONTROL REPORTS**

The project QAC will be responsible for performing periodic, unannounced audits of the field activities that will be performed for the BANGF SI. These audits will be conducted to ensure that the SI is performed according to the procedures described in the project QCP, Sampling and Analysis Plan, and Health and Safety Plan. All audits and corrective actions will be reported in writing to the Project Manager. These reports will be summarized and included in the final SI report.

The SI Field Manager will provide the Project Manager with daily field reports, compiled field data, and corrective action documentation at appropriate intervals. Situations that require immediate corrective action will be reported to the Project Manager as soon as possible. Based on the information obtained from the Field Manager and the QAC, the Project Manager will prepare monthly status reports that will be submitted to the USAEC COR.

### **15.2 LABORATORY QUALITY CONTROL REPORTS**

A QA report that summarizes all QA activities and QC data will be submitted by the Laboratory Director to the QAC and the Project Manager with the analysis data. The Laboratory Director will also be required to provide QA update memoranda (i.e., copies of all field custody forms and laboratory sample status and custody forms) upon completion of analysis of each group of samples submitted. The Project Manager and the QAC will be notified immediately of QA situations requiring immediate corrective action (i.e., recollection of samples).

### **15.3 DATA QUALITY ASSESSMENT**

The final SI report will include a discussion of the quality of data generated during the SI. This section of the report will include results of laboratory method blanks, MS/MSDs, control charts, holding times, calibration criteria, trip blanks, equipment rinsates, and field duplicates. The data quality assessment will also include a discussion of PARCC parameters, QC frequency, audits, and corrective actions.

## 16.0 REFERENCES

- Stollar, R.L., & Associates, Inc. et al., January 1991. Draft-Final Quality Control Plan, Bennett Army National Guard Facility, Remedial Investigation and Feasibility Study.
- Stollar, R.L., & Associates, Inc. et al., January 1991. Draft-Final Sample Design Plan, Bennett Army National Guard Facility, Remedial Investigation and Feasibility Study.
- Stollar, R.L., & Associates, Inc. et al., January 1991. Technical Plan, Bennett Army National Guard Facility, Remedial Investigation and Feasibility Study.
- U.S. Army Toxic and Hazardous Materials Agency, January 1990. U.S. Army Toxic and Hazardous Materials Agency Quality Assurance Program. Prepared for Commander U.S. Army Toxic and Hazardous Materials Agency. Aberdeen Proving Ground, MD 21010-5401.
- U.S. EPA, Environmental Monitoring and Support Laboratory Office of Research and Development, March 1979. Methods for Chemical Analysis of Water and Wastes.
- U.S. EPA, Office of Solid Waste and Emergency Response, November 1986. Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition.
- U.S. Army Toxic and Hazardous Materials Agency, March 1987. Geotechnical Requirements Drilling, Monitoring Wells, Data Acquisition, and Report. Department of the Army U.S. Army Toxic and Hazardous Materials Agency. Aberdeen Proving Ground, MD 21010-5401.
- U.S. EPA, Office of Solid Waste and Emergency Response, (No Date). Guidance for Performing Site Inspections Under CERCLA, Interim Final.

## **APPENDIX A**

### **Laboratory Data Consultants, Inc. Data Validation Review Process**

**LABORATORY DATA CONSULTANTS, INC.**

7750 El Camino Real, Suite 2C, Carlsbad, CA 92009 Phone: 619/634-0437 Fax: 619/634-0439

**Data Validation Review Process**

The data validation review process will follow the requirements stated in the project's Quality Assurance Project Plan (QAPP). If data validation procedures and criteria are not clearly stated in the QAPP, Laboratory Data Consultants, Inc. will follow internal validation procedures which were developed using Environmental Protection Agency (EPA), Air Force Center for Environmental Excellence (AFCEE), and Naval Energy and Environmental Support Activity (NEESA) Quality Assurance/Quality Control program guidelines, as applicable. The data validation procedures will comply with the following five documents:

- "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program", NEESA 20.2-047B, June 1988.
- "Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses", February 1, 1994.
- "Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses", July 1, 1994.
- "Handbook to Support the Installation Restoration Program (IRP) Statements of Work", Dept. of the Air Force, May 1991.

The review process will be handled in a stepwise fashion. All samples for one analysis will be batched together and evaluated against each individual validation criteria. The validator will document each finding on a Validation Findings form. Along with the finding, the reviewer will document the date of the occurrence, the lab reference identification, the validation criteria, the associated samples, and the qualification of the data. An example of a Validation Findings form is enclosed for review (Attachment I). For EPA Level 4 review, several recalculations are required. Attachment IIa is an example worksheet for initial calibration recalculations. Attachment IIb is an example worksheet for sample recalculations. As an example, after the criteria for the initial calibration has been reviewed, the Validation Checklist form is marked noting if validation criteria was met or exceeded. Validation Checklists are enclosed for review (Attachment IIIa and Attachment IIIb). Attachment IIIa representing EPA Level 3 validation and Attachment IIIb representing EPA Level 4 validation. These checklists are used as an inventory sheet to assure all samples were reviewed for each criteria. The findings documented on the Validation Findings form will be transcribed into the final summary report.

All initial validation performed by Laboratory Data Consultants, Inc. has a secondary review. All final reports will be reviewed by a Senior Chemist.

Page:      of       
 Reviewer:                       
 2nd Reviewer:                     

## VALIDATION FINDINGS WORKSHEET

### Initial Calibration

LDC #: \_\_\_\_\_  
SDG #: \_\_\_\_\_

METHOD: GC/MS VOA (EPA CLP SOW OLM01.8)

please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A Did the laboratory perform a 5 point calibration prior to sample analysis?

	Y	N	N/A
Were all percent relative standard deviations (%RSD) $\leq 30\%$ and relative response factors (RRF) $\geq 0.05$ ?			

[illegible]

A. Chloromethane	G. Carbon disulfide	M. 2-Butanone	S. Trichloroethene*	Y. 4-Methyl-2-pentanone	EE. Ethyl benzene*
B. Bromomethane*	H. 1,1-Dichloroethene*	N. 1,1,1-Trichloroethane*	T. Dibromochloromethane*	Z. 2-Hexanone	FF. Styrene*
C. Vinyl chloride*	I. 1,1-Dichloroethane*	O. Carbon tetrachloride*	U. 1,1,2-Trichloroethane*	AA. Tetrachloroethane*	GG. Xylene*
D. Chloroethane	J. 1,2-Dichloroethane	P. Bromodichloromethane*	V. Benzene*	BB. 1,1,2,2-Tetrachloroethane*	HH. _____
E. Methylene chloride	K. Chloroform*	Q. 1,2-Dichloropropane	W. trans-1,3-Dichloropropene*	CC. Toluene*	II. _____
F. Acetone	L. 1,2-Dichloroethane*	R. cis-1,3-Dichloropropane*	X. Bromoform*	DD. Chlorobenzene*	JJ. _____

Attachment IIa  
**VALIDATION FINDINGS WORKSHEET**  
**Continuing Calibration Results Verification**

LDC #: \_\_\_\_\_ Page: \_\_\_\_\_ of \_\_\_\_\_  
 SDG #: \_\_\_\_\_ Reviewer: \_\_\_\_\_  
 2nd Reviewer: \_\_\_\_\_

**METHOD: GC/MS VOA (EPA CLP SOW OLM01.8)**

The percent difference (%D) of the initial calibration average Relative Response Factors (RRFs) and the continuing calibration RRFs were recalculated for the compounds identified below using the following calculation:

Where: ave. RRF = initial calibration average RRF  
 RRF = continuing calibration RRF  
 $\% \text{ Difference} = 100 \times (\text{ave. RRF} - \text{RRF}) / \text{ave. RRF}$   
 $\text{RRF} = (A_s / C_s) / (A_i / C_i)$   
 $A_s$  = Area of compound,  $A_i$  = Area of associated internal standard  
 $C_s$  = Concentration of compound,  $C_i$  = Concentration of internal standard

#	Standard ID	Calibration Date	Compound (Reference Internal Standard)	Average RRF (Initial)	Reported		Recalculated	
					RRF (CC)	%D	RRF (CC)	%D
1			Methylene chloride (1st internal standard)					
			Trichlorethene (2nd internal standard)					
			Toluene (3rd internal standard)					
2			Methylene chloride (1st internal standard)					
			Trichlorethene (2nd internal standard)					
			Toluene (3rd internal standard)					
3			Methylene chloride (1st internal standard)					
			Trichlorethene (2nd internal standard)					
			Toluene (3rd internal standard)					
4			Methylene chloride (1st internal standard)					
			Trichlorethene (2nd internal standard)					
			Toluene (3rd internal standard)					

Comments: Refer to Continuing Calibration findings worksheet for list of qualifications and associated samples when reported results do not agree within 10.0% of the recalculated results.

Attachment lib

## VALIDATION FINDINGS WORKSHEET

### Sample Calculation Verification

LDC #: \_\_\_\_\_  
SDG #: \_\_\_\_\_

Page: \_\_\_\_\_ of \_\_\_\_\_  
Reviewer: \_\_\_\_\_  
2nd reviewer: \_\_\_\_\_

**METHOD: GC/MS VOA (EPA CLP SOW OLM01.8)**

Compound results for \_\_\_\_\_ reported with a positive detect were recalculated and verified using the following equation:

$$\text{Concentration} = \frac{(A_1)(I_1)(DF)}{(A_2)(RRF)(V_2)(\%S)}$$

$A_x$	=	Area of the characteristic ion (EICP) for the compound to be measured
$A_s$	=	Area of the characteristic ion (EICP) for the specific internal standard
$I_s$	=	Amount of internal standard added in nanograms (ng)
RRF	=	Relative response factor of the calibration standard.
$V_o$	=	Volume or weight of sample purged in milliliters (ml) or grams (g).
Df	=	Dilution factor.
%S	=	Percent solids, applicable to soils and solid matrices only.

**Example:**

Sample I.D. \_\_\_\_\_, \_\_\_\_\_

$$\text{Conc.} = \frac{(\quad)(\quad)(\quad)}{(\quad)(\quad)(\quad)(\quad)}$$
[illegible]

Note: MeCL<sub>2</sub> = Methylene chloride

## Attachment IIIa

LDC #: \_\_\_\_\_ **VALIDATION COMPLETENESS WORKSHEET**  
 SDG #: \_\_\_\_\_ EPA Level III NEESA Level C  
 Laboratory: \_\_\_\_\_

Date: \_\_\_\_\_  
 Page: \_\_\_\_\_ of \_\_\_\_\_  
 Reviewer: \_\_\_\_\_  
 2nd Reviewer: \_\_\_\_\_

METHOD: GC/MS VOA (EPA CLP SOW OLM01.8)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Technical holding times		Sampling dates:
II.	GC/MS Instrument performance check		
III.	Initial calibration		
IV.	Continuing calibration		
V.	Blanks		
VI.	Surrogate spikes		
VII.	Matrix spike/Matrix spike duplicates		
VIII.	Laboratory control samples		
IX.	Regional Quality Assurance and Quality Control	N	
X.	Internal standards		
XI.	Target compound identification	N	
XII.	Compound quantitation/CRQLs	N	
XIII.	Tentatively identified compounds (TICs)	N	
XIV.	System performance	N	
XV.	Overall assessment of data		
XVI.	Field duplicates		
XVII.	Field blanks		

Note: A = Acceptable  
 N = Not provided/applicable  
 SW = See worksheet

ND = No compounds detected  
 R = Rinsate  
 FB = Field blank

D = Duplicate  
 TB = Trip blank  
 EB = Equipment blank

## Validated Samples:

1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	



## Attachment IIIb

LDC #: \_\_\_\_\_  
 SDG #: \_\_\_\_\_  
 Laboratory: \_\_\_\_\_

**VALIDATION COMPLETENESS WORKSHEET**

\_\_\_\_ EPA Level IV \_\_\_\_ NEESA Level D

Date: \_\_\_\_\_  
 Page: \_\_\_\_ of \_\_\_\_  
 Reviewer: \_\_\_\_\_  
 2nd Reviewer: \_\_\_\_\_

**METHOD: GC/MS VOA (EPA CLP SOW OLM01.8)**

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Technical holding times		Sampling dates:
II.	GC/MS Instrument performance check		
III.	Initial calibration		
IV.	Continuing calibration		
V.	Blanks		
VI.	Surrogate spikes		
VII.	Matrix spike/Matrix spike duplicates		
VIII.	Laboratory control samples		
IX.	Regional Quality Assurance and Quality Control	N	
X.	Internal standards		
XI.	Target compound identification		
XII.	Compound quantitation/CRQLs		
XIII.	Tentatively identified compounds (TICs)		
XIV.	System performance		
XV.	Overall assessment of data		
XVI.	Field duplicates		
XVII.	Field blanks		

Note: A = Acceptable  
 N = Not provided/applicable  
 SW = See worksheet

ND = No compounds detected  
 R = Rinsate  
 FB = Field blank

D = Duplicate  
 TB = Trip blank  
 EB = Equipment blank

## Validated Samples:

1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	



**LABORATORY DATA CONSULTANTS, INC.**

7750 El Camino Real, Suite 2C, Carlsbad, CA 92009 Phone: 619/634-0437 Fax: 619/634-0439

January 26, 1995

CKY Environmental Services, Inc.  
3480 Torrance Blvd., Suite 100  
Torrance, CA 90503  
Attn: Mr. Tan Phung

**Subject: Data Validation Procedures**

Dear Mr. Phung,

Laboratory Data Consultants, Inc. (LDC) would be pleased to support your Army Corps of Engineers project with third party data validation services. I have enclosed a document describing the "Data Validation Review Process".

LDC is an experienced DOD data validation subcontractor under the following contracts:

- Navy CLEAN Southwest Division (Bechtel National)
- Navy CLEAN Southwest Division (Jacobs Engineering Group)
- Navy CLEAN Pacific Division (Ogden Environmental)
- Navy CLEAN Pacific Northwest (URS Consultants, Inc.)
- Army Corps of Engineers, Fort Ord (Harding Lawson)
- Army Corps of Engineers/AFCEE, George AFB (Montgomery Watson)
- AFCEE, McClellan AFB (Jacobs Engineering Group)

LDC is classified as a small disadvantaged business enterprise for government procurements.

We appreciate this opportunity to support CKY in the performance of this Army Corps project. Please feel free to call me at (619) 634-0437 if you have any questions.

Sincerely,

Richard M. Amano  
President/Principal Chemist